PEABODY COAL COMPANY

301 NORTH MEMORIAL DRIVE · ST. LOUIS, MISSOURI 63102
(314) 342-3472

June 24, 1976

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. J. M. Brown, Jr.
Radioisotapes Licensing Branch

Re: Control No. 00709
(Docket No. 70-2272)

Gentlemen:

We hope the information as presented meets with your request and approval.

Item 1 Section 70.22 of 10 CFR Part 70.
Item IV, Section A, Page 3
Principal officers of:
Peabody Coal Company
301 North Memorial Drive
St. Louis, Missouri 63102

E. R. Phelps - President & Chief Executive Officer
R. E. Miller - Executive Vice President
E. S. Jones - Vice President Administration
M. O. Young - Vice President General Counsel
M. H. Mohl - Vice President Finance

All of Peabody's principal officials are U.S.A. citizens and all have their headquarters in our home office located in St. Louis, Missouri.

Item 2 The only disposable item contemplated would be in the form of thin aluminum sheet filters (about 4" X 4" x .001" thick). These would be buried in the strip pits of Peabody's adjacent surface mine and the depth below grade level would be over 25 feet.

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Item 3 The required six (6) month leak testing of the sealed source will be conducted by a recognized outside laboratory licensed to perform such test.

Item 4 Pete Bacchetti and Jack Ellis will supervise the installation and calibration of the device. Presently, Joe Johnson and Anthony DeLuzio will be responsible for the day to day operation of the device. (There could be replacements in the above personnel in the future).

The above (and any future replacement) personnel will be instructed relative to all phases of the operation of the device including the handling of the radioactive isotope even though we do not anticipate that they will ever be given the task of handling the isotope. A copy of the procedures from the manual as supplied by the manufacturer is submitted for your approval.

Item 5 Emergency and decontamination procedures as outlined in Subitem 8, Page 18 of the guide will be carried out.

Many thanks for your kind indulgence.

Sincerely,

Pete Bacchetti

Pete Bacchetti

PB/dg
encs.
cc: Mr. Jack J. Ellis

THE NCB/AERE PHASE 3A CONTINUOUS ASH MONITORING SYSTEM

SECTION A: PRINCIPLE AND METHOD

1. PRINCIPLE

The radiation absorption coefficient of a chemical element increases with its atomic number (Z). Coal is composed of several chemical elements, each having a different radiation absorption coefficient. The inert residue (ash) left after the combustion of coal consists of elements such as silicon, aluminium, sulphur and iron, of relatively high atomic numbers and therefore relatively high absorption coefficients. Other constituent elements of lower Z value, such as carbon, hydrogen, oxygen and nitrogen have lower absorption coefficients and are either combustible or do not leave a solid residue after burning. Thus the elements that leave ash will backscatter less X-rays from a radioactive isotope than will those that do not produce ash.

The NCB/AERE Phase 3A Continuous Ash Monitoring System utilises this principle to provide a rapid and accurate determination of ash content by measuring the backscattered radiation from a sample of coal irradiated by a radioactive isotope. The amount of backscattered radiation varies inversely with the ash content of the coal sample and is continuously recorded.

2. METHOD OF MEASUREMENT

Coal is presented under two radioactive isotopes, from which X-rays are absorbed or backscattered. The backscattered radiation is detected by means of a proportional counter in which it is converted to electrical pulses that are amplified and counted in an electronic control unit. In turn, these pulses are converted to a ratemeter voltage reading and a milliampère control signal. The ratemeter reading can be recorded.

The mean absorption coefficients of the heavier and of the lighter groups of elements in the coal sample will not normally vary greatly because, compared with the difference in absorption coefficients between the two groups, the differences in coefficients within a group are relatively small. An exception to this is however produced when there are present in the coal high proportions of iron and (to a lesser extent) calcium; these would result in disproportionately high ash readings, because the absorption coefficients of these elements are considerably higher than those of the other elements producing residue after combustion. The variations in [illegible] significant than those in calcium content. A method of compensation is adopted that reduces the margin of error of ash determination resulting from the iron content variation.

The method makes use of the property of elements that produces fluorescent X-rays when irradiated by primary X-rays. Iron produces measurable quantities of fluorescent X-rays when subjected to radiation of 15 to 17 keV, emitted from the plutonium 238 source used. These fluorescent X-rays are counted along with the higher-energy backscattered radiation and selectively filtered to yield the necessary compensation. The filter consists of a thin aluminium foil placed over the radiation detector window. No further energy selection is required.

Measurement of the backscattered radiation thus gives a measure of the ash content of the coal.

The counting system was developed by the Atomic Energy Authority. The presentation unit and the electronic control unit were developed by MRDE.

3. METHOD OF OPERATION

This section gives a brief general description of the method of operation of the NCB/AERE Phase 3A Continuous Ash Monitoring System. The successive stages are described in detail in the sections that follow.

The system comprises several main components: sampler, smoothing conveyor, crusher, feed chute, presentation unit containing radioactive isotopes, electronic control unit and return conveyor. Sample chutes, collection points and collecting bins are provided as required.

Coal is collected from a main conveyor by the sampler and fed at a controlled rate by the smoothing conveyor, moving at such a speed that a continuous ribbon of coal is presented to the crusher. There it is reduced to minus 5-mm size and then delivered (by means of an elevating conveyor if necessary) to the presentation unit. In this unit, the sample is fed via an arc-shaped chute onto a table near its centre. A cam deflects the coal, as it rotates on the table, radially outwards across the table from the inner radius to the outer radius of the feed chute. Continued discharge into the annulus so created pushes the coal further across the table until it is compressed horizontally between the cam plate and an outer

profile plate. More coal fed into the annulus pushes the original feed out beyond the outer profile plate, whence it is discharged from the table by means of a scraper. At the same time as it is being compressed horizontally, the coal is compressed vertically by means of a sloped compression plate mounted above the coal bed.

Resulting from the application of these two compression forces, a compact bed of coal with a smooth top surface is presented under the radioactive isotopes. After irradiation in the presentation unit, and measurement of the backscattered radiation, the coal sample is discharged onto the return conveyor.

4. SAMPLING SYSTEM

This should follow generally the flow diagram shown in Figure 1.

4.1 Sampler

The sampler shown in Figure 1 is a Bretby bucket sampler, but any sampler that will deposit a strip of coal on to the smoothing conveyor is suitable. Samplers of the Pollock type, which deliver the sample to a single point, are not suitable. In this section, it is assumed that a bucket sampler is in use. The sampler is timed to give a maximum feedrate to the system of 18 kg/min (40 lb/min) of coal when the feed to be sampled is passing the sampling point at maximum flowrate. The sampler bucket deposits the sample along the length of a short smoothing conveyor. The depth of sample on the belt will vary in accordance with the quantity of the sample, while the length of sample on the belt will be constant.

4.2 Smoothing Conveyor

This is a slow-moving conveyor arranged so that its direction of travel is in line with the length of the bucket. Its speed is such that one sample just clears the space below the bucket as the next sample is delivered. Thus, if the bucket contains 18 kg (40 lb) at maximum throughput rate, and is, say 1.5 m (5 ft) long, the conveyor belt should travel 1.5 m (5 ft) between sample deposits. As this deposit is 18 kg (40 lb) in quantity there will be one deposit each minute. Therefore the conveyor speed should be 1.5 m/min (5 ft/min). Similarly, if the bucket contains only 9 kg (20 lb) at maximum throughput rate, the conveyor speed would need to be 3 m/min (10 ft/min) with a sample taken every 30 s; and conversely a 36-kg (80 lb) sample would have to be taken at 2-min intervals. However, if the output signal is used to control a blend, sampling must be as frequent as possible.

In this way, an intermittent deposit of sample is converted into a continuous ribbon feed to the crusher. Because the conveyor is running slowly, it must be of minimum length in order to avoid delay in getting the sample to the monitor and thus extending the time between sampling and result.

4.3 Intermediate Sampling

It is possible to provide a sample collection point in the chute running from the smoothing conveyor to the crusher. If this is done, the diverting door should not be open to collect the sample for more than 2–3 s as any longer period will prevent a continuous ribbon feed reaching the monitor.

An advantage of the Bretby sampler is that it can deliver samples to chutes at either end of its travel. Thus it can furnish a sample to the presentation unit and a sample for moisture determination or other requirements without interrupting the continuous ribbon feed. Some other bucket samplers will also deliver in this manner. The provision for sample collection from the chute to the crusher need not then be considered.

4.4 Crusher

A crusher is required to reduce the feed consistently to −5 mm. The 'Lightning' series WSIM crusher has been found suitable. The double-roller inlet of this crusher is a considerable advantage in preventing blockage.

4.5 Elevating Conveyor

It is assumed that an elevating conveyor will be required to transfer the sample to the monitor room and to gain height. If this is not necessary, the conveyor can be omitted, but if incorporated it should run at the maximum speed possible to avoid delays – typically at 75 m/min (250 ft/min) for a 0.38-m (15-in) wide belt. It should discharge into a chute that feeds the presentation unit or onto a belt feeder.

4.6 Feed to Presentation Unit

Either of two methods of feeding the presentation unit can be used:

(a) Direct chute feed (indicated in Figure 1). In this method the sampled material is fed via a chute to the presentation unit. If a sample reject chute is also fitted, provision must be made in it to feed in calibration samples at a point below the sample-reject diverting door.

(b) Feed via belt feeder (not shown in Figure 1). In this method the feed chute below the diverting door is in the shape of a hopper. Discharge to the presentation unit is then via a belt feeder fitted with a variable-speed drive. During normal operation the chute must not retain any sampled material and the belt-feeder speed is set to deliver in excess of 18 kg/min (40 lb/min). During calibration work the calibration sample is deposited into the chute and the belt-feeder speed is reduced so that the sample is discharged to the presentation unit at a suitable rate for the calibration.

4.7 Sample Reject Chute

This chute is optional and its incorporation will depend on other sampling considerations.

If it is incorporated, the diverting door must operate automatically to reject the sampled material if the presentation unit table stops. It must also be in the reject position during calibration work. It is

not then necessary to stop the rest of the sampling system.

If it is not incorporated, the whole sampling system must stop if the presentation unit table stops. The sampling system must also be stopped during calibration work.

4.8 Presentation Unit

The presentation unit (Figure 2) and detection/measuring equipment (Figure 3) are described in sections 5–10 below.

4.9 Discharge from Presentation Unit

A diverting door, which is normally open to the return conveyor, allows coal to pass either to return or to a sample collecting bin.

4.10 Return Conveyor

This conveyor returns the coal to the main conveying system.

4.11 General

4.11.1 Interlocks

When the presentation unit is being controlled remotely, interlocks are provided so that if the table stops, the belt feeder (if fitted) also stops and the feed-chute diverting door moves to the reject position.

When the diverting door in the feed chute is set to reject it must be possible to operate the presentation unit (and the belt feeder, if fitted) from inside the ash monitor room for test purposes. Figure 4 shows the electrical control circuits required.

4.11.2 Chutes

Chutes should be as steep as possible with valley angles not less than 60° from the horizontal. The normal path of the coal should be made as near vertical as possible, any diversions from normal flow being out of the vertical. Chutes should be lined with material of low friction coefficient (e.g. high-density polyethylene).

5. PRESENTATION UNIT

Figures 5–8 illustrate the following sections; items detailed in Figures 6–8 are listed in Appendix 1, section 2.

5.1 Summary of Operation

See Figure 5. Samples of coal previously crushed to 5 mm–0, the ash content of which is to be determined, are delivered continuously on to a rotating table (1) via a feed chute (2). As the table rotates in a clockwise direction, the feed is directed radially outwards on the table by the fixed eccentric semicircle XY. The feed is then guided by the concentric semicircle YZ round the outside of the feed chute (2). Further feed pushes the original feed across the table until it reaches the outer retaining ring (3). Because this ring (3) is concentric with the table, the coal bed is compressed horizontally between it and the eccentric semicircle XY. A vertical compression is applied between point Y and the outer retaining ring (3) by means of a sloping plate (4) mounted above the coal on the underside of the profile plate (5). Thus a compacted bed of coal is formed and is examined by the radiation from two plutonium 238 isotopes mounted above it on the radiation detector (6). As coal continues to be fed to the table, excess coal is divided from the bed at the leading edge of the outer retaining ring (3) and is then discharged from the table by the scraper (7) into the discharge chute (8).

5.2 Mechanics of Operation

See Figures 6a–6c. The mild-steel turntable (10) is fitted with a renewable mild-steel plate (9). The uppermost surface of the renewable plate is coarsely machined to prevent the coal sample from slipping on the surface of the turntable. Screwed and keyed to the underside of the turntable is a short stub shaft (7), connected to a vertically mounted reduction-gear unit by a flexible coupling (49). The turntable (10) is supported and located by a deep grooved ball-race (51), which is protected from the ingress of dirt by felt washers (17) and (18).

The vertically mounted motor (47) is connected to the input shaft of the reduction-gear unit by means of a V-belt (65) and pulleys (64) and (66). The whole drive is enclosed by a split guard (27). As the drive motor is fitted to an adjustable baseplate (29), the V-belt can be tensioned by means of an adjusting screw (28). The stainless-steel inlet chute (6) is fixed to the presentation unit frame (1). The sides of the chute extend to a position just clear of the surface of the turntable, apart from the side adjacent to the profile plate (4). This side of the chute is cut away to allow passage of the coal sample under the profile plate.

The mild-steel profile plate (4) is situated over a 180° arc above the surface of the turntable (10). The distance between the surface of the turntable and the underside of the profile plate is approximately 50 mm. Fitted to the underside of the profile plate (4) at the end remote from the inlet chute (6) is a stainless-steel wedge-shaped compression plate of maximum thickness 5 mm. This plate compresses the coal sample vertically to a height of 45 mm above the surface of the turntable and also smooths the top surface of the coal sample prior to its passage beneath the radiation beam emitter-detector.

The inner wall of the chute (6) continues below the profile plate in the form of a vertically sided cam (8) having a maximum eccentricity of 60 mm, equal to the width of the inlet chute (6). The maximum eccentricity of the cam (8) occurs at the exit from the profile plate (4). The cam (8) is concentric with the turntable (10) between the end of the profile plate (4) and the outer wall of the inlet chute (6). This cam is kept clean by the spring-loaded scraper assembly (Figure 7). Welded to the periphery of the profile plate (4) is a vertical retaining plate. Radial compression of the coal

sample takes place under the profile plate (4) over a width of 180 mm between the cam (8) and this retaining plate. The retaining plate continues beyond the end of the profile plate (4), concentric with the turntable, to a point on the centre line of the framework behind the inlet chute (6). A radial spillage plate situated over an arc of 45° between the end of the compression plate ring and the scraper (12) allows the vertical edge of the coal sample to fall away and be deflected by the stainless-steel scraper (12) into a discharge hopper (30).

Situated adjacent to the discharge end of the profile plate and positioned radially relative to the centre of the turntable is the radiation beam detector-emitter, which consists of a cylindrical proportional counter and a pair of isotopes. The whole assembly is mounted in a steel box which is bolted and locked to the framework of the presentation unit.

5.3 Proportional Counter Assembly

See Figures 8 and 9. Two plutonium 238 isotopes (1/11) are secured in a source holder (1/5) which is screwed onto a cylindrical proportional counter (1/9). The proportional counter is mounted in end caps (1/2) and (1/3) and can be rotated through 270°. Graphite (1/7) and steel (1/6) reference blocks are situated on either side of the proportional counter and the whole assembly is mounted on a support plate (1/1) and bolted to the inside of the top cover of the proportional counter box (3). One end of the proportional counter (1/9) is fitted with a screwed electrical connection to which a short length of cable is fitted. This cable passes from the end of the proportional counter through a hole in the top cover of the proportional counter box and is connected to a pulse-amplifier which is mounted externally on the top cover of this box. The other end of the proportional counter (1/9) is fitted with a dial extension piece (1/4) which projects through the side of the proportional counter box. Indentations in the dial (1/4) engage with a spring-loaded ball (1/13), (1/14), (1/15) situated within the outer end cap (1/3), and positively locate the proportional counter in any of three positions, i.e. with source holder facing (a) the turntable, (b) the steel reference block (1/6) or (c) the graphite reference block (1/7). The isotope is in its **'SAFE'** position when the source holder (1/5) is facing the support plate (1/1), i.e. rotated 180° from its working position.

The proportional counter can be rotated, in an anti-clockwise direction only, from its reference or working position to the **'SAFE'** position and, clockwise only, from the **'SAFE'** position to the reference or working position. This prevents the electrical socket on the end of the proportional counter from becoming unscrewed.

5.4 Interlocking System

See Figures 8 and 9. An interlocking system has been incorporated between the proportional counter box and the framework of the presentation unit. This system allows the proportional counter box to be removed from the framework when the isotope is in its **'SAFE'** position only (see Figure 8).

A Castell Type KL bolt lock (14), is fitted to the side of the proportional counter box adjacent to the dial extension piece. With the isotope in its operating position, the bolt is withdrawn and two keys (15) are trapped within the lock. When turned through 180° the isotope is in its **'SAFE'** position. The bolt can now be extended and enters a hole in the dial extension piece (1/4), locking the isotope in its **'SAFE'** position and releasing the two Castell keys (15). These two keys are then used to unlock two separate Castell-type FT2 interlocks, at 'A' and 'B' in Figure 9, locking the proportional counter box (3) to the mainframe.

When unlocked, the keys are trapped in the locks and the proportional counter box can be withdrawn from the presentation unit, the isotope being locked in its **'SAFE'** position. When the proportional counter box is refitted on the presentation unit framework the two Castell-type FT2 interlocks are engaged and the proportional counter box is secured to the framework. The two keys are then released and both can then be inserted in the Type KL lock (14). The bolt of this lock can then be withdrawn, trapping the two keys in the lock and allowing the isotope to be rotated anti-clockwise through 180° into its working position.

The proportional counter and isotope can only be withdrawn from the proportional counter box by using two master keys (16); these keys must **ALWAYS** be in the possession of the colliery radiation security officer. They may be issued to **'CLASSIFIED WORKERS'** only, who must always sign for them before issue.

5.5 Counting System

The Phase 3A Continuous Ash Monitoring System was designed to analyse coal samples having a particle size of 5 mm–0. Time delays previously associated with the fine grinding and drying of coal samples have been considerably reduced.

The radiation beam detector-emitter consists of an argon-filled proportional counter (see Appendix 2) and two plutonium 238 radioactive iostopes that emit low-energy X-rays at an energy level of 15 to 17 keV. As stated, this radiation is directed into the bed of coal and is absorbed or back-scattered to a degree dependent on the absorption coefficients of the elements present. Iron compounds in the coal present difficulties, but at the energy level of the isotope the iron is excited and produces fluorescent X-rays of 5-keV energy level. This excitation is a feature of the system and permits these X-rays to be partially filtered out, thus compensating for the high absorption coefficient of iron. The two isotopes are mounted in a common holder below the specially designed proportional counter, which is relatively efficient in detecting the fluorescent X-rays. Between the beryllium window of the proportional counter and

the isotope is fitted an aluminium foil; the thickness can be chosen to filter out the correct proportion of the 5-keV X-rays.

When a dc voltage (about 1350 V) is applied to a wire within the proportional counter, ions formed by the action of the radiation on the argon gas are attracted, resulting in small current pulses. These pulses are counted electronically.

5.6 Radioactive Isotopes

Details of the radioactive source are:

Two plutonium 238 low-energy gamma isotopes; disc type; 7-mC activity each; X71 capsules Code PPC4 having a half-life of 86 years. The isotopes are available from the Radio Chemical Centre, Amersham, Bucks.

5.7 Data

Capacity	: 18 kg/min (40 lb/min) continuous ribbon feed when sampling from a maximum conveyor feedrate
Material presented	: 5 mm (3/16 in) – 0 coal
Turntable speed	: 19 rev/min
Coal bed	: 180 mm wide × 45 mm deep
Weight of coal on turntable	: 8 kg (18 lb) approximately
Time required for coal to traverse across turntable	: 27 s at 18 kg/min (40 lb/min) maximum feedrate
Weight of presentation unit	: 630 kg (12½ cwt)

6. SAFETY DEVICES

The ash monitor presentation unit is fitted with three electromechanical safety devices (see Figures 6a–6c).

6.1 Break in V-belt

Should the V-belt (65) connecting the drive motor (47) to the vertically mounted reduction unit (63) break, the turntable (10) would immediately stop, although the drive motor (47) would continue running. This situation is detected by three magnetic actuators (70), equally pitched and fitted to the underside of the turntable (10), and a proximity switch (71). Each time a magnet (70) passes over the switch (71), an electrical pulse is transmitted to a pneumatic timing relay which is incorporated in the electrical circuit to the drive motor (47). Should the timing relay not receive a pulse, as would occur when the turntable (10) stops, the circuit is broken and the power to the drive motor (47) is cut off.

6.2 Stalled Turntable

Should the turntable (10) stop owing to jamming of oversize material between the turntable plate (9) and the underside of the profile plate (4), the stalled current produced is detected by the overload dashpots in the motor starter and the power supply to the drive motor (47) is cut off.

6.3 Displacement of Radioactive Source

Should one or both of the radioactive isotopes be accidentally displaced from the source mount, the countrate falls below a preset value and a relay in the electronic control unit is operated, cutting off the power supply to the drive motor (see section 10.6). This ensures that the displaced isotopes remain within the coal bed on the turntable. A blue light on the electronic unit is illuminated when this condition arises and

THE RADIATION SECURITY OFFICER MUST BE INFORMED IMMEDIATELY.

When the turntable is stopped for any of the reasons mentioned above, the coal samples being delivered to the presentation unit feed chute must be instantly and automatically diverted from the presentation unit by means of the by-pass chute, where fitted. Where no by-pass chute is fitted the whole sampling system must be stopped.

If Radioactive isotopes are displaced The unit will automatically shut down.

SECTION C: SETTING UP, CALIBRATION, TESTING, MAINTENANCE

13. SETTING-UP PROCEDURE

13.1 Equipment Required

The following equipment is required for setting-up the electronics of the NCB/AERE Phase 3A Continuous Ash Monitoring System:

1. An electrostatic voltmeter capable of reading up to 2000 V dc.

2. A scaler timer with a six-digit display and storage gate times of 1 s, 10 s and 100 s. It should have a bandwidth of at least 2 Hz to 1 MHz and maximum sensitivity of 10 mV rms (sinewave), with an input impedance not less than 1 MΩ and input capacitance not greater than 15 pF. A suitable instrument is the Advance Instruments Counter Type TC83A.

3. A high-input-impedance (≥ 1MΩ) dc voltmeter capable of reading up to 15 V, (preferably with digital display).

4. An ohmmeter.

5. A stopwatch.

6. A milliammeter (where the output is used as an electrical signal) 0–25 mA dc.

7. A test pressure gauge 0–15 lbf/in² (where the output is converted to a pneumatic signal).

13.2 General Comments

The chart recorder and output stage signals have three built-in time-constants designated TC1, TC2 and TC3, the values being approximately 10 s, 20 s and 30 s respectively. When setting the chart recorder or output stage, a time of not less than five times the time-constant setting must be allowed to elapse between successive adjustments.

Any readings of EHT voltage must also be made after time has been allowed for actual changes in voltage. This time is normally a minimum of 10 s.

WHEN THE COAXIAL LEAD FROM THE EHT/PULSE AMPLIFIER UNIT TO THE PROPORTIONAL COUNTER OR VOLTMETER IS TO BE DISCONNECTED, A TIME OF NOT LESS THAN ONE MINUTE MUST ELAPSE BETWEEN SWITCH-OFF AND DISCONNECTION. This allows the EHT voltage to discharge through the 220-MΩ resistor chain.

13.3 Sequence of Action

See Figure 19.

1. Remove the control unit from its case and remove the lid from the EHT/pulse amplifier unit.

2. Connect PL1 (Figure 19) through a Plessey Mk 4 Size 1 three-pin free socket (orientation 4) to a 110-V ac supply. Connect pins A and B to the 110-V ac supply and pin C to earth. Do **NOT** connect the EHT/pulse amplifier unit.

3. Connect the high-impedance dc voltmeter (section 13.1, item 3) between pins 15 and 1 of board No. 4 (stabilised power supply board). Pin number 15 is positive.

4. Switch on the supply at the control unit and adjust multiturn potentiometer RV1/→, situated on the stabilised supply board, until a reading of 12 V is indicated on the voltmeter.

5. Switch off the supply and disconnect the voltmeter.

6. Connect SK2 (Figure 19) through a Plessey Mk 4 Size 1 four-pin free plug (orientation 1) to the EHT/pulse amplifier unit. The connection at this unit is made through a Plessey Mk 4 size 1 four-pin free socket (orientation 5). Cut the connecting cable to the required length and connect pin A to pin A, pin B to pin B, pin C to pin C, and pin D to pin D of the free plug and socket. Connect the terminated cable to the control unit and to the EHT/pulse amplifier unit.

7. Ensuring that the power supply is **OFF,** connect the electrostatic voltmeter (item 1) to the coaxial socket in the EHT/pulse amplifier unit.

8. Set the EHT potentiometer, situated on the front panel of the control unit, to zero and switch on the supply. The voltmeter should read 1000 V; if necessary, adjust potentiometer RV7 on the stabilised supply board. Reset the EHT potentiometer to 5.00 and check that the voltmeter reading is 1500 V. Adjust if necessary, using potentiometer RV6. Repeat this procedure several times, re-adjusting RV6 and RV7 until both settings are correct. Set the EHT potentiometer to 10.00 and check that the voltmeter reading is 2000 ± 50 V.

Note: If either the EHT/pulse amplifier unit or the control unit is changed, readjustment of the EHT control circuit will be necessary.

9. Switch off the supply at the control unit and after a minimum time of one minute, disconnect the electrostatic voltmeter.

(**Early Production Units:** in early units the preset controls RV6 and RV7 are not provided and the EHT control setting bears only an arbitrary relationship to the output voltage. When setting up these early models it is necessary to plot the actual EHT voltage against the multiturn EHT control setting. A specific voltage can then be selected by reference to the graph so derived.)

10. Adjust the 'gain' and 'threshold' of the pulse amplifier (main circuit board) as follows:

(a) With the power supply **OFF,** connect an ohmmeter (item 4) across test points TP1 and TP2 (see figures 13 and 26) and adjust gain control

RV1 until the ohmmeter reads 100 Ω. Disconnect the ohmmeter.

(b) Connect the dc voltmeter (item 3) across test points TP3 and TP4, with TP3 as positive. Switch the supply **ON**, and adjust the threshold control RV2 to give a reading of 0.20 V on the meter (see Figures 13 and 26). Switch the supply **OFF** and disconnect the meter.

11. Remove the proportional counter box from the presentation unit. Turn the proportional counter, with no isotopes attached, to the **'SAFE'** position. This will shield the detector from any atmospheric radiation.

12. Connect the proportional counter to the EHT/pulse amplifier unit through the coaxial cable provided.

13. Connect the scaler timer to the coaxial outlet socket situated at the rear of the control unit. Set the gate of the scaler timer to count continuously.

14. Set the EHT potentiometer on the control unit to an EHT voltage of about 1650 V and switch on the supply. Any noise in the system will then be indicated by counts on the scaler timer. Although the level of the threshold control (as set in 10(b) above) is normally sufficient to prevent noise, any residual counts can be eliminated by rotating RV2 clockwise.

15. Switch off the supply, and after waiting for at least one minute, disconnect the cable between the EHT/pulse amplifier unit and the control unit.

16. Arrange for a **CLASSIFIED WORKER** to attach the two radioactive isotopes to the proportional counter, and to insert the filter supplied.

17. Replace the proportional counter box on the presentation unit. Reconnect the cable between the control unit and the EHT/pulse amplifier unit.

18. Set the EHT potentiometer on the control unit to zero.

19. Turn the proportional counter to face the **steel** reference block.

20. Set the scaler timer gate setting to 100 s.

21. Switch on the supply.

22. After allowing at least one minute for the EHT voltage to build up, note the frequency reading on the scaler timer.

23. Increase the EHT potentiometer settings in increments of 0.25, noting the corresponding frequency readings up to a maximum voltage of 1650 V. At least 10 s must be allowed after each variation of the EHT potentiometer before starting the scaler timer.

24. Reduce the EHT potentiometer to zero.

25. Plot a graph of frequency against voltage. An example is shown in Figure 27.

26. Turn the proportional counter to face the **graphite** reference block.

27. Note the frequency indicated on the scaler timer.

28. Increase the EHT potentiometer settings in increments of 0.25, noting the corresponding frequency readings, up to a maximum of 1650 V.

29. Plot a graph of frequency against voltage for the graphite reference block. This should be plotted on the same sheet as the previous graph (see Figure 27).

30. The choice of a suitable operating EHT voltage is indicated in Figure 27, and will normally be about 25 V above the minimum voltage at which both steel and graphite counts attain a 'plateau'. Ideally, this voltage should be approximately 1340 V.

31. Switch off the supply at the control unit.

Chronologically, on-site calibration now follows, and stages 32 – 78 of the setting-up procedure would be completed after the calibration. However, for ease of presentation, these further stages are listed here, and on-site calibration is described in section 14.

32. Remove the perspex window from the chart recorder and lift the chart drive lever (see Figure 28). This ensures that the chopper bar is raised and the recorder pointer is free to move.

33. Adjust the zero-set lever (Figure 28) until the chart recorder needle registers zero on the scale.

34. Reset the chart drive lever.

35. Disconnect the pulse amplifier and replace it with the simulator. Switch on the supply.

36. Unscrew all the potentiometer locks on the front of the control unit, i.e. 'source lost', level and gain.

37. Set the time-constant switch to the TC1 position.

38. Set the scaler timer to measure pulse rate frequency with a 1-s gate time. If the recommended scaler timer is used (see section 13.1, item 2), set the display control to 'Store and Print' and the sample rate control to 'Minimum'.

39. Switch on the supply.

40. Adjust the simulator potentiometer until a frequency reading corresponding to the minimum percentage of ash being considered is registered on the scaler timer (see section 14 and Figure 29).

41. Adjust the level potentiometer on the control unit until the chart recorder reading is zero. A time of at least one minute must be allowed for settling.

42. Set the simulator to give a frequency corresponding to the maximum percentage ash being considered (see section 14 and Figure 29).

43. Adjust the gain potentiometer on the front of the control unit until the chart reads full scale.

44. Repeat actions 39 – 43 above, making any final adjustments necessary to improve setting accuracy.

45. Lock the level and gain potentiometers.

46. Determine the frequency required to operate the 'source lost' relay. The method is given in Appendix 4.

47. Adjust the simulator potentiometer to give this frequency.

48. Adjust the 'source lost' potentiometer on the control unit until the blue 'source lost' light just switches on.

49. Lock the 'source lost' potentiometer and switch off the supply.

50. Connect external leads to the 'source lost' relay socket SK4 (Figures 10 and 19) on the control unit through a Plessey Mk 4 Size 1 three-pin free plug (orientation No. 3). Under healthy conditions the relay should be energised, so that pins A and C are short-circuited and pins A and B are open-circuited. Check for correct operation, using an ohmmeter.

51. Connect SK3 (Figures 10 and 19) through a Plessey Mk 4 Size 1 three-pin free plug (orientation 2) to the electropneumatic transducer or other load. Make connections to pins A and C, pin A being positive.

Instructions 52 to 58 below apply when an **electrical signal output** is utilised.

52. Connect the milliammeter (section 13.1, item 6) into the output circuit.

53. Switch on the supply and set the simulator to give a frequency corresponding to the minimum percentage ash being considered.

54. Adjust the output level multiturn potentiometer (RV2/3) on the output stage board until the corresponding current is indicated on the milliammeter.

55. Set the simulator to give a frequency corresponding to the maximum percentage ash being considered.

56. Adjust the output gain multiturn potentiometer (RV1/3) on the output stage board until the corresponding current is indicated on the milliammeter.

57. Repeat tests 53 – 56 above, making any fine adjustments necessary to improve the setting accuracy.

58. Switch off the supply and disconnect the milliammeter.

Instructions 59 – 65 below apply when the output is converted to a **pressure signal.**

59. Connect a test pressure gauge (item 7) to the output of the electropneumatic transducer.

60. Switch on the supply and set the simulator to give a frequency corresponding to the minimum percentage ash being considered

61. Adjust the output level multiturn potentiometer (RV2/3) on the output stage board until the corresponding pressure is indicated on the test pressure gauge.

62. Set the simulator to give a frequency corresponding to the maximum percentage ash being considered.

63. Adjust the gain multiturn potentiometer (RV1/3) on the output stage board until the corresponding pressure is indicated on the test pressure gauge.

64. Repeat tests 60 – 63 above, making any fine adjustments necessary to improve the accuracy.

65. Disconnect the pressure gauge.

66. Set the time-constant switch to the 'integrate' position.

67. Set the simulator to give a frequency of 1250 Hz.

68. Observation of the chart recorder needle will show that it moves slowly from right to left and then moves quickly from left to right across the scale. Note the time taken for ten complete cycles using the stopwatch (item 5).

69. Increase the frequency in increments of 250 Hz up to the simulator maximum, noting the corresponding time for ten cycles in each case.

70. Plot a graph of frequency against time per cycle. An example of this is shown in Figure 3[illegible]. The purpose of this graph is to give a rough indication of the pulse rate when a scaler timer is not available.

71. Switch off the supply external to the control unit.

72. Remove all free plugs and sockets from the rear of the control unit and insert the control unit back into its case.

73. Reconnect all the plugs and sockets to the control unit and switch on the supply.

74. Turn the time-constant selector switch to TC1.

75. With the chart running, select a position for the proportional counter which will give a trace on the chart at approximately half full scale. This may be selected by an intermediate position between the steel or graphite test block and the table.

76. Using the scaler timer, take a total pulse count over 100 s and delete the last two digits to give the countrate per second.

77. Leave the chart for several hours (e.g. overnight) at this setting. The trace should not drift and short-term variations about the mean should correspond to a standard deviation in countrate of

$$s = \sqrt{\frac{\text{mean countrate per second}}{2 \times \text{ratemeter time-constant}}}$$

Note: The formula for standard deviation of count rate given in 77 above assumes a Poisson distribution of particle emission. Derivation of the formula is given in standard text books, such as Whitehouse and Putman, 'Radioactive Isotopes', OUP 195[illegible] Chapter V, Section 7.

The total spread B between 95% confidence limits = 4 δ. If the ratemeter time-constant = 10 s for setting TC1, then

$$B = 0{\cdot}894\sqrt{\text{mean countrate.}}$$

The actual value of B can be obtained by measuring the peak-to-peak variation on the chart and relating this to the calibration as set out under instructions 40 – 44 above.

78. Take another total pulse count over 100 s and delete the last two digits. The countrate per second thus obtained should closely approximate to that obtained under 76 above.

14. ON-SITE CALIBRATION

1. Collect twenty samples of coal, each of 60-lb minimum weight, from the coal flow through the presentation unit. Keep them in sealed plastic bags to retain the moisture.

2. Bypass the presentation unit or stop the sampling system and clean the table thoroughly.

3. For safety, remove the outer profile scraper, since the coal bed must also be removed completely.

4. Connect the scaler timer (section 13.1, item 2) to the electronics control unit and set the time gate to a 10-s period. If the recommended instrument is used, set the sample rate to 'Minimum', and the display to 'Store and Print'.

5. Move the diverting door below the presentation unit so that the sample can be collected in a clean sample bin.

6. Deposit the first sample in the calibration hopper and feed at a rate of less than 40 lb per min to the presentation unit table.

7. As the bed builds up a gap, caused by the operation of the inner scraper, is apparent. When this disappears, stop the feed and the presentation table.

8. Return any coal in the sample collection bin to the calibration hopper.

9. Restart the presentation unit and the feed. At the same time start the scaler timer by pressing the reset button.

10. Total counts for 10-s periods should be displayed with no significant delay between periods. Record these counts for the period when coal is flowing on to the presentation unit turntable.

11. Immediately the flow ends, stop the presentation unit and feeder.

12. Return the coal from the sample collection bin to the calibration hopper.

13. Repeat sequence 9 – 12 four times.

14. On completion of the fourth pass of coal through the presentation unit, remove all the coal from the table. Care must be taken to avoid damaging the cam scraper.

15. Return the coal to its plastic bag.

16. Treat each of the twenty samples as in sequence 6 – 15.

17. Divide each sample into four equal subsamples and carry out a duplicate 'as-received' ash determination on each subsample.

18. Average the ash values obtained for each subsample to obtain an ash content for the whole sample.

19. Average the counts totals for each sample to give counts per second, relating the latter to the relevant ash content.

20. Calculate a straight-line regression of counts per second against ash content (see Figure 29). This will give the accuracy of determination of ash content and also the relative counts-per-second values for the maximum and minimum ash contents being considered.

15. TESTING

15.1 Requirements

The equipment (less the milliammeter and the pressure gauge) listed in section 13.1 is also needed for testing the electronics of the standard ash monitor (as defined in section 7). The high-impedance voltmeter should preferably give a digital reading. In addition, the following are needed:

1. An ac power supply that can be varied over the range 100 V to 120 V, 50 Hz. The maximum current consumption will not exceed 500 mA.

2. An oscilloscope capable of displaying pulses dc to 1 MHz, of 1 mV/cm sensitivity, input resistance not less than 1 MΩ, and input capacitance not greater than 40 pF.

3. A pulse generator capable of generating square-wave pulses over the amplitude range 0·5 mV to 2·0 V positive and negative, and frequency range 800 Hz to 10000 Hz. The pulse width should be variable between 0·1 μs and 100 μs and the rise time variable between 0·01 μs/V and 1 μs/V.

4. A 170-Ω fixed resistance, 0·5-W rating.

5. A variable dc power supply 0 – 15 V, 250 mA of good regulation.

15.2 Standard Control Unit MRD 51402

15.2.1 Power Supplies

1. Connect PL1 through a Plessey Mk 4, Size 1 three-pin free socket (orientation 4) to the variable ac power supply (section 15.1, item 1). Connect pins A and B to the ac supply, and pin C to earth.

2. Connect the high-impedance voltmeter (section 13.1, item 3) between wires Nos. 14 and 10. Wire No. 14 is positive (see Figure 19).

3. Set the variable ac supply to 110 V and switch on the supply.

4. Vary the multiturn potentiometer RV1/4, situated on the stabilised supply board, between

its limits. The dc voltage should vary at least over the range of 11·82 V dc to 12·95 V dc.

5. Adjust RV1/4 to give 12 V dc between wires Nos. 14 and 10.

6. Vary the ac supply voltage between 100 and 120 V. The voltage between wires Nos. 14 and 10 should vary by not more than ± 2 mV from the set value of 12 V.

7. Reset the supply voltage to 110 V ac.

8. Connect the high-impedance voltmeter (section 13.1, item 3) between wires Nos. 1 and 10. Wire No. 1 is positive (see Figure 19).

9. Vary the EHT potentiometer, situated on the front of the control unit, between zero and 10.00. Record the voltage between wires Nos. 1 and 10 for each limit.

10. Set the EHT potentiometer dial to 5·00 and note the dc voltage between wires Nos. 1 and 10.

11. Vary the ac supply voltage between 100 and 120 V. The voltage between wires Nos. 1 and 10 should vary by not more than ± 2 mV.

12. Reset the supply voltage to 110 V ac.

15.2.2 Ratemeter Board

1. Set the Time Constant/Integrate switch situated on the front of the control unit to the TC1 position.

2. Connect the pulse generator (section 15.1, item 3) between pins A and C of SK2. Pin C is earth. Set the pulse generator to the following conditions:

Frequency = 2000 Hz ± 10%.
Amplitude = 1·4 V ± 10%, positive going.
Pulse width = 15 μs ± 2 μs.
Rise time 0·1 μs/V.

3. Connect the scaler timer (section 13.1, item 2) to the coaxial socket at the rear of the control unit, and set the gate time to 1 s.

4. Note the frequency indicated on the scaler timer. This should be the same as that set on the pulse generator.

5. Connect the high-impedance dc voltmeter (section 13.1, item 3) between wires Nos. 22 and 10. Wire No. 22 is positive.

6. Set the pulse generator frequency to 1000 Hz and note the dc voltage.

7. Set the pulse generator frequency to 3000 Hz and note the dc voltage.

8. The voltage level should have risen by not less than 0·6 V dc.

9. Connect the high-impedance voltmeter between wires Nos. 20 and 10. Wire No. 20 is positive.

10. Set the pulse generator frequency to 1000 Hz and note the dc voltage.

11. Set the pulse generator frequency to 3000 Hz and note the dc voltage.

12. The voltage level should have risen by not less than 1·5 V dc.

15.2.3 Schmitt Trigger Board

1. Set the pulse generator frequency to 2500 Hz.

2. Adjust the 'source lost' potentiometer, situated on the front of the control unit, until the blue 'source lost' light just switches on.

3. Vary the pulse generator frequency between 2000 Hz and 3000 Hz.

4. The 'source lost' light should switch off at a frequency of not more than 3000 Hz and switch on at a frequency of not less than 2000 Hz.

5. Set the pulse generator frequency to 1000 Hz.

6. Adjust the 'source lost' potentiometer until the 'source lost' light just switches on.

7. Vary the pulse generator frequency between 800 and 1200 Hz.

8. The 'source lost' light should switch off at a frequency of not more than 1200 Hz and switch on at a frequency of not less than 800 Hz.

9. Connect an ohmmeter (section 13.4, item 4) between pins A and B of SK4.

10. Set the pulse generator frequency to 800 Hz.

11. The ohmmeter should show zero resistance.

12. Set the pulse generator frequency to 1200 Hz.

13. The ohmmeter should show an open-circuit condition.

14. Connect the ohmmeter between pins A and C of SK4.

15. Set the pulse generator frequency to 800 Hz.

16. The ohmmeter should show an open-circuit condition.

17. Set the pulse generator frequency to 1200 Hz.

18. The ohmmeter should show zero resistance.

19. Disconnect the ohmmeter.

20. Turn the time-constant switch, on the front of the control unit, to the 'INT' position.

21. Connect the high-impedance dc voltmeter (section 13.1, item 3) between wires Nos. 12 and 10. Wire No. 12 is positive.

22. Set the pulse generator frequency to 2000 Hz.

23. The voltage between wires Nos. 12 and 10 should increase slowly as capacitor C3/5 charges and then reduce quickly. The cycle should then repeat automatically.

24. Using the stopwatch (section 13.1, item 5), note the time for ten complete cycles and hence calculate the time/cycle

25. The time/cycle should be 25 s ± 2 s. If it is not, then adjust potentiometer RV1/2, situated on the Schmitt trigger board, until the time/cycle falls within this range.

15.2.4 Chart Recorder

1. Turn the switch on the front of the control unit to the TC1 position.

2. Turn the gain control to the maximum gain i.e. fully clockwise.

3. Connect the high-impedance voltmeter between wires Nos. 24 and 10. Wire No. 24 is positive.

4. Set the pulse generator frequency to 2000 Hz.

5. Vary the level control, situated on the front of the control unit, between its limits.

6. The voltage should vary at least over the range 3 V to 7 V dc.

7. Set the pulse generator frequency to 3000 Hz.

8. Adjust the level control until the chart recorder needle registers zero on the scale.

9. Set the pulse generator frequency to 1000 Hz.

10. Adjust the gain control, situated on the front of the control unit, to register full scale.

11. Repeat tests 7 – 10 above making any fine adjustments necessary to increase accuracy. A time of at least one minute must be allowed to let the chart recorder needle settle.

12. Set the pulse generator frequency to 2000 Hz.

13. After allowance for the time-constant, the chart recorder should settle at half scale ± 2%.

15.2.5 Output Stage Board

1. Connect the 170-Ω resistor (section 15.1, item 4) between pins A and C of SK3.

2. Connect the high-impedance voltmeter across the resistor, pin A being positive.

3. Set the pulse generator frequency to 3000 Hz, so that the chart recorder reads zero.

4. Adjust the output level potentiometer RV2/3 until 0.68 V is indicated on the voltmeter.

5. Set the pulse generator frequency to 1000 Hz, so that the chart recorder reads full scale.

6. Adjust the output gain potentiometer RV1/3, situated on the output stage board, until 3.4 V is indicated on the voltmeter.

7. Repeat tests 3 – 6 above, making any fine adjustments to increase accuracy.

8. Set the pulse generator frequency to 2000 Hz.

9. After allowing for the time-constant, the voltage across the 170-Ω resistor should be 2·04 V ± 0·05 V dc.

15.3 EHT/Pulse Amplifier Unit

15.3.1 EHT Generator

1. Connect the variable dc supply (section 15.1, item 5) to pins D and C of the Plessey Mk 4 fixed plug on the EHT/pulse amplifier unit. Pin D is positive.

2. **BEFORE SWITCHING ON THE SUPPLY,** connect the electrostatic voltmeter (section 13.1, item 1) to the coaxial outlet socket on the pre-amplifier.

3. Set the voltage on the dc power supply to 5·5 V and switch on the supply.

4. After allowing at least one minute for the EHT voltage to build up, check that the EHT voltage indicated on the electrostatic voltmeter is between 700 V and 980 V.

5. Set the dc power voltage to 11·5 V.

6. Again allow one minute for the EHT voltage to increase and then note the voltage indicated on the electrostatic voltmeter. This voltage should be not less than 2000 V.

7. Disconnect the dc power supply. Allow at least one minute to elapse and disconnect the electrostatic voltmeter.

15.3.2 Pulse Amplifier

1. Connect the dc power supply (section 15.1, item 5) between pins B and C of the Plessey Mk 4 four-pin fixed plug on the pulse amplifier, with pin B as positive. Set the voltage to 12 V dc.

ENSURE THAT NO VOLTAGE SOURCE IS CONNECTED TO PIN D OF THE PLESSEY FIXED PLUG.

2. Connect the pulse generator to the coaxial outlet socket on the pulse amplifier. The pulse generator should be set to give the following pulse forms.

Frequency	= 2 kHz ± 10%.
Amplitude	= 1 mV negative ± 10%.
Width	= 0·95 μs ± 10%.
Rise and fall times	< 0·1 μs/V.

3. Connect the oscilloscope between pins A and C of the Plessey fixed plug. Pin C is common.

4. Switch on the supply and note the waveform displayed on the oscilloscope. This should have the following characteristics.

Frequency	= as generated by the pulse generator
Amplitude	= 1·4 V positive ± 0·2 V.
Pulse width	= 3–5 μs measured at 10% of maximum amplitude.

5. Reduce the supply voltage to 10·5 V dc and note the waveform displayed on the oscilloscope. The pulse amplitude should vary in proportion to the voltage, but the width should remain between 3 and 5 μs.

6. Increase the supply voltage to 13·5 V dc. The waveform should be as specified in Test 4, above, except for increased amplitude.

7. Set the supply voltage to 12 V dc.

8. Set the pulse generator frequency to 500 Hz, with the same pulse shape as specified in Test 2 above.

9. Check the output waveform on the oscilloscope. This should comply with the specification stated in Test 4 above.

10. Set the pulse generator frequency to 10 kHz, with the same pulse shape as specified in Test 2 above.

11. Check the output waveform on the oscilloscope. This should again comply with the specification stated in test 4 above.

12. Disconnect the dc power supply, pulse generator and oscilloscope.

15.4 Simulator

1. Connect the dc power supply to pins B and C of the Plessey Mk 4 fixed plug on the simulator. Pin B is positive.

2. Connect the oscilloscope between pins C and A of the Plessey fixed plug. Pin C is common.

3. Set the supply to 12 V dc and switch on.

4. Observe the waveform displayed on the oscilloscope. This should have the following characteristics:

Amplitude = 1·4 V positive ± 0·2 V.
Pulse width = 15–25 μs, measured at 10% of maximum amplitude.

5. Vary the setting of the potentiometer situated on the simulator lid, between its limits. The output frequency should vary at least over the range 1000 to 3500 pulses/s.

6. Check that the green indicator light is on.

7. Disconnect the dc power supply and the oscilloscope.

8. Connect the dc power supply between pins D and C of the Plessey Mk 4 fixed plug, with D as positive. Set the voltage to 7 V dc and switch on the supply.

9. The white indicator light on the simulator should be on, but should be of low intensity.

10. Increase the dc supply voltage to 12 V.

11. The intensity of the white light should increase with voltage up to normal brightness at 12 V dc.

12. Disconnect the dc power supply.

16. MAINTENANCE

16.1 General

The mechanical components of the system (see section 4), with the exception of the presentation unit, are standard pit equipment and it is not considered necessary to publish maintenance information here. Maintenance of the presentation unit is discussed in section 16.2.

Similarly, malfunction of electronic components, unless cured by the comparatively simple immediate actions detailed in the fault finding chart at Appendix 5, will usually call for attention from a qualified service engineer and, for example, the replacement of a faulty circuit board. Further electronic maintenance information is therefore also omitted.

16.2 Mechanical Maintenance of Presentation Unit

See Figures 6a – 6c.

16.2.1 Greasing

Three grease nipples (55) positioned diametrically opposite the discharge chute (30) project through the side cover plate (40) of the presentation unit. The top nipple is used to grease bearing 51. The middle and bottom nipples are used to grease the top bearings of the gear-reduction unit (63).

16.2.2 Lubrication

The gear-reduction unit (63) holds 13 pints of lubricating oil and is filled through the filler and level pipe which projects through the side cover plate (46) of the presentation unit. Recommended oil for the gear reduction unit is **NOT** to NCB Specification but is **WALKERS (CENTURY OILS) LIMITED CENTURY A11 OIL, OR DAVID BROWN GRADE NO. 6, OR APPROVED EQUIVALENT.** When it is required to drain the oil from the gear-reduction unit, the side cover plates must be removed from the presentation unit framework and the socket-headed drain plug removed from the side of the gear-reduction unit (63).

16.2.3 Removal of Cover Plates

All side and top cover plates are removable. It is not possible for contact to be made with the isotope when the cover plates are removed.

16.2.4 Removal of Isotopes

REMOVAL OF THE RADIOACTIVE ISOTOPE FROM THE PROPORTIONAL COUNTER MUST BE UNDERTAKEN BY A CLASSIFIED WORKER ONLY.

16.2.5 Removal of Coal Bed

See Figure 6(b).

Internal scrapers follow the cam (8) and outer retention plate of the profile plate (4). If it is necessary to remove the coal bed from the presentation unit, a special scraper (item 120 in Appendix 1, section 2) must be used. This scraper is inserted into the slot in the profile plate (4), adjacent to the feed hopper (6). Care must be taken to ensure that it is not hit by the internal scrapers and to this end the stop plate of the special scraper should be lowered onto the top of the profile plate (4). Not all of the coal bed can be removed by this scraper, but sufficient is deflected to carry out any checks necessary. **DO NOT REMOVE SCRAPER ACCESS PLATE (LABELLED) WHILE TURNTABLE IS RUNNING**

16.2.6 Cleaning of Profile Plates

See Figure 6(a).

The proportional counter box should be removed at least once a month. The coal bed should be removed and any coal built up on the profile plate (4) and cam (5) should be removed. Particular care should be taken to ensure that no built-up material remains in the corners between items 4 and 8.

NOTE: Care should be taken to ensure that the proportional counter is not jarred when the counter box is handled.

See Appendix 6 for lists of spares.