URANIUM

OLYMPIC DAM

Annual Radiation Protection Report

July 2009 - June 2010

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Olympic Dam
BHP Billiton Limited
Uranium CSG
ABN 99 007 835 761

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OLYMPIC DAM

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July 2009 - June 2010

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1 INTRODUCTION

This document is the annual report on radiation protection for BHP Billiton Olympic Dam Incorporation Pty Ltd and includes the following:

In fulfilment of clause 2.10.1, 3.8.1 and 3.10.1 of the Code of Practice and Safety Guide on Radiation Protection and Radioactive Waste Management in Mining and Processing 2005, employee dose assessments, dose calculation methodologies, dose parameters and dose conversion factors for the period 1st July 2009 to 30th June 2010 are presented. Individual personal doses and dose components for the period 1st July 2009 to 30th June 2010 are forwarded with this document on electronic media.

2 EMPLOYEE DOSE ASSESSMENT METHOD

2.1 Exposure Calculation Methodology

2.1.1 Exposure Calculation at the Mine

The main exposure pathways for Mine workers are inhalation of Radon Decay Products (RDP), irradiation by gamma radiation and inhalation of radioactive dust. Assessment of exposure from dust and RDP are based on employee time sheet/card information and measurements from the approved monitoring program.

Employee and contractor time card information is entered into one of the three time tracking databases [IRIS, SAP, Production Tracking Normal Time (Prodtrak_Normtime)] for either daily or monthly work periods. The site security database (CARDAX) is also used to determine the monthly average hours for individuals whose timesheets have not been logged into any of the other databases mentioned above. The information from CARDAX is converted into tables that can be easily imported into the IRIS database for dose calculation. Each database records employee name, employee number, occupation, date, work location and hours in location information.

Locations within the Mine are grouped into areas of ‘like air’ known as airways. The Senior Ventilation Engineer or their nominee, who is familiar with the underground environment, maintains the locations within the airways. Airways are segregated into weekly periods and new locations are mapped into their relevant airway this results in there being 13 weekly groupings each quarter covering the history of ventilation throughout the Mine.

The RDP concentration is then determined for each airway for each week using measurements from the approved monitoring program, which covers monitoring of most active work areas. For work airways not sampled in that week, an average is calculated. This average is calculated from all readings for that particular airway over the quarter.

Employee exposure to radioactive dust is calculated using quarterly occupation-based averages. The averages are obtained from monitoring performed under the approved monitoring program. An occupation-based dust concentration level is then allocated to each occupation.

The occupation-based dust concentration information and location-based RDP concentration information is then combined with the employee time card information to derive individual exposure data. Dust exposure is measured in units of Becquerel-hours per cubic metre (Bq.hr/m3) and RDP concentration is measured in units of micro Joule-hours per cubic metre (µJ.hr/m3). Exposure details are combined to give quarterly personal exposures.

The entire procedure is processed using a software program known as the Integrated Radiation Information System (IRIS). The system is designed such that the Radiation Safety Officer is required to perform checks in each step of the process. This is in addition to a built-in auditing system within the program.

Respiratory protection in the form of airstream helmets are available for all employees and are worn when tasks are identified as requiring them. They are typically worn by some workgroups such as Ore Handling Beltrunners and Services Ventilation Crew. Airstream helmets are also mandatory for identified specific tasks or in certain conditions. Routine and non-routine use of airstream helmets is monitored and logged.

No respiratory protection factors are used in these exposure calculations, and therefore actual individual exposures will be lower than reported.

Exposure to gamma radiation is assessed using Thermo Luminescent Dosimeters (TLD's) badges from the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Personal Monitoring Service. TLD badges are worn for a period of three months; non-badge wearers are allocated an occupation-based average exposure.

2.1.2 Exposure calculation in the Metallurgical Plant

The main exposure pathways for Metallurgical Plant workers are inhalation of radioactive dust and fumes, and irradiation by gamma radiation. Assessment of exposure from dust and fumes is based on employee time sheet/card information and measurements from the approved monitoring program. Dust exposure in the Metallurgical Plant may involve exposure to different types of dust. These dusts will differ in particle size and radionuclide composition, which will produce different dust Dose Conversion Factors (DCF's). The table of DCF's is given in Appendix A.

Information from employee and contractor time cards or employee activity sheets is entered into IRIS via one of the three databases [IRIS (Manual), SAP, Prodtrak] containing daily or monthly information, depending on work area and occupation. From these databases a file of unique locations/occupations is obtained. Locations of the same section or similar exposure are grouped into exposure groups. A quarterly mean of dust activity is determined for each of the exposure groups based on the results of the monitoring program.

CARDAX is used to extract time sheet information for all personnel where it is not possible to get this information from the three main databases commonly used at Olympic Dam for timesheet logging (IRIS, Prodtrak and SAP).

Quarterly location/occupation dust averages are combined with time information to produce a dust exposure for each employee and each different dust type.

Exposure to gamma radiation is assessed using TLD badges from the Personal Monitoring Service of ARPANSA. TLD badges are worn for a period of three months. They are issued to all occupation groups with designated employees. The balance of employees receive the average exposure for their occupation group. TLD badges are issued to different employees every monitoring period. Employees from occupation groups which are likely to receive elevated gamma dose are issued a TLD badge each monitoring period (eg. Slag Crushers, Mill Technician, Product Packer, Slag Handling Technician, TRS Technician, Instrumentation Technician working with radiation gauges). Spare TLD badges are also kept on hand to be issued to employees upon request.

Although the exposure to RDP within the Metallurgical Plant is much less than other pathways, it is assessed in the same way as for Mine employees. The same time information used for calculation of dust exposure is used for calculating RDP exposure. All surface locations/occupations are grouped into one surface airway. A weekly average is calculated from all surface RDP measurements and is assigned to this airway. Location-based RDP concentration information is then combined with the employee time card information to derive individual weekly exposure data ($\mu J.hr/m^3$).

2.2 Exposure to Dose Calculations

Conversion of dust exposure to committed effective dose is achieved by the use of dose conversion factors, which are derived using the methodologies in ICRP68/72. The parameters physically measured to determine the factors are; particle size and radionuclide content. These measurements are undertaken in a number of areas of the Mine and Metallurgical Plant.

Analysis of the samples used to determine the radionuclide content was carried out by the Olympic Dam Analytical Laboratory. These results were used to determine dose conversion factors, which remain unchanged from last year.

Changes to existing conversion factors will only occur in the event of introduction of new processing techniques, major changes to plant or ore type or new recommendations published by the ICRP. A summary of the dose conversion factors used for 2009/2010 is given in Appendix A. Dose conversion factors have been carried over from the previous reporting year.

To calculate committed dose for airborne dust exposure, the airborne dust exposure is multiplied by the appropriate dose conversion factor. The committed doses for the different dusts are then added to give a total airborne dust dose.

Dose equivalent from RDP are calculated by multiplying the RDP exposure by the default dose conversion factor recommended by ICRP65 of 1.41 $mSv.m^3/mJ.hr$ (5 mSv/WLM).

3 Employee Doses

3.1 Doses to Mine Employees

3.1.1 Descriptive Statistics

A total of 670 full-time designated Mine worker's doses were calculated for the period 1st July 2009 to 30th June 2010. This included all BHP Billiton Olympic Dam Mine employees and associated contractors. The distribution of doses for these work classifications is given in Figure 1.

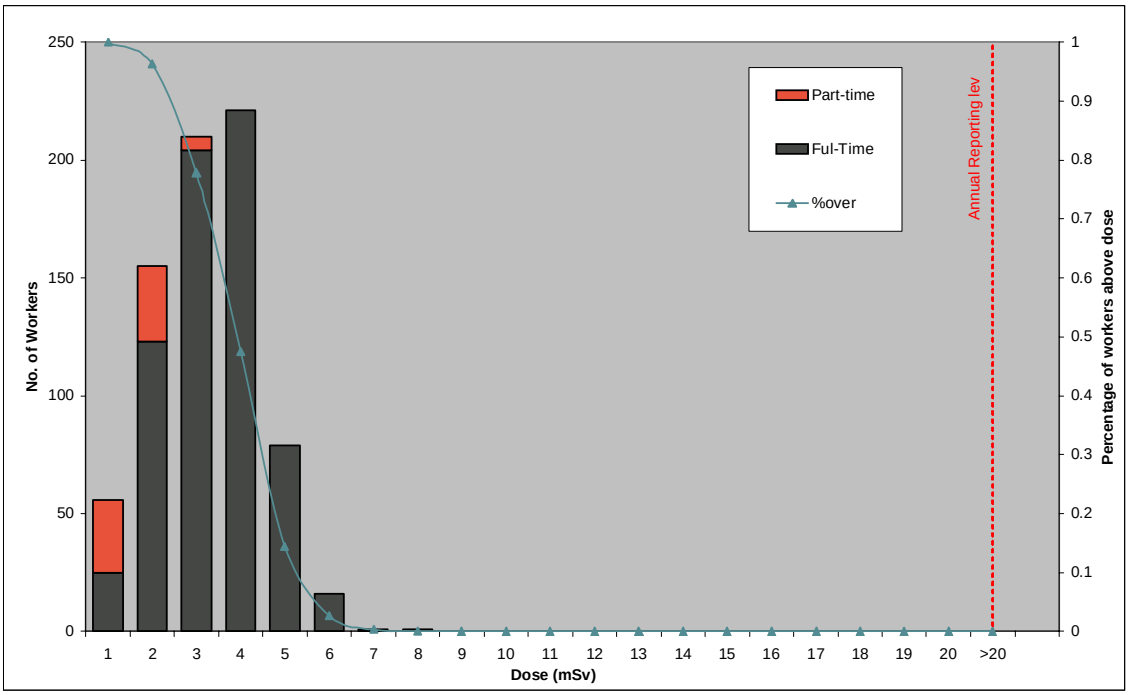


Figure 1 - Annual Dose Distribution 2009/2010 for All Designated Employees - Mine

The selection criteria for determining whether employees are categorised as 'full- time' or 'part-time' is as follows:

A 'full-time' Mine employee is an employee whose dose has been assessed for a total of three or more quarters in the Mine. A 'part-time' employee therefore has dose assessment for less than three quarters. This eliminates any unintentional biasing of the analysis of data due to short exposure periods.

The mean dose to all designated mine employees was 2.8 mSv in 2009/2010, a decrease from the 2008/2009 value of 3.4 mSv.

The mean dose for full-time designated mine workers was 2.9 mSv in 2009/2010, a decrease from the 2008/2009 value of 3.5 mSv.

The mean dose for part-time designated mine workers was 1.5 mSv in 2009/2010, a decrease from the 2008/2009 value of 3.0 mSv.

The average exposure to radon decay products (RDP) in the underground mine for 2009/2010 was just over 16% lower than in 2008/2009.

Table A consolidates the results for the exposures at the mine.

Table A – Statistics for designated employees, mine

Statistics	Full-Time Designated Employees	Part-Time Designated Employees	All Designated Employees
Count	670	69	739
Arithmetic Mean (mSv)	2.9	1.5	2.8
90th Percentile (mSv)	4.2	1.9	4.0
Min (mSv)	0.4	0.1	0.1
Max (mSv)	7.3	2.7	7.3
Mean % Dose from RDP	58%	57%	58%
Mean % Dose from Dust	5%	5%	5%
Mean % Dose from Gamma	37%	38%	37%

No Mine worker received an annual dose greater than 10 mSv. The highest dose was 7.3 mSv, compared to a maximum value in 2008/2009 of 8.3 mSv.

3.1.2 Review of doses by work category

Table B shows the breakdown of doses by work category for full-time designated employees.

The total number of all designated employees has decreased to 739 in the 2009/2010 year from 834 in 2008/2009 due to a reduction in workforce numbers. The primary focus of our monitoring programs has remained on the critical workgroups that are currently working in the underground mine.

Of the three major exposure pathways (gamma irradiation, inhalation of radioactive dust and inhalation of RDP), the gamma irradiation exposure levels for full-time designated workers has remained the same at 37%. While RDP has increased marginally from 57% in 2008/2009 to 58% of the total dose in 2009/2010. The dust component remained constant at around 5% of the total dose.

Average annual doses for all mine work groups have continued to decrease during the 2009/2010 year. The Raise Driller work group received the highest average dose of 4.7 mSv, a reduction from 2008/2009. The highest individual annual dose of 7.3 mSv was also received by a Raise Driller.

The dose components for all work categories are shown graphically in Figure 2

Table B – Statistics for Full Time Designated Mine Employees

WORK CATEGORY	No. of Emp.	Mean (mSv)	Minimum (mSv)	Maximum (mSv)	90th Percentile (mSv)
Backfill	7	1.5	0.6	2.1	2.1
Core Farm	6	0.7	0.5	0.7	0.7
Development	102	3.4	1.6	5.3	4.3
Diamond Driller	22	3.0	0.8	4.3	4.2
Electrician	28	2.5	1.4	5.6	4.5
Fitter	61	1.8	0.9	4.1	2.5
Mine Surface	42	1.7	0.4	3.6	3.0
Ore Handling	152	3.3	1.1	5.0	4.0
Production Charger	14	4.1	2.4	5.2	4.7
Production Drilling	32	3.5	1.6	5.3	4.4
Raise Driller	17	4.7	2.4	7.3	6.2
Services	187	2.7	0.8	5.4	3.8

WORK CATEGORY	RDP. Average (mSv)	RDP. % of Total Dose	Gamma Average (mSv)	Gamma % of total Dose	Dust Average (mSv)	Dust % of Total Dose
Backfill	0.8	57%	0.5	35%	0.1	7%
Core Farm	0.1	18%	0.2	31%	0.3	51%
Development	1.9	55%	1.3	38%	0.2	6%
Diamond Driller	2.0	65%	1.0	32%	0.1	3%
Electrician	1.1	42%	1.3	52%	0.1	6%
Fitter	1.0	54%	0.7	38%	0.2	8%
Mine Surface	1.0	58%	0.6	35%	0.1	6%
Ore Handling	2.1	65%	1.0	31%	0.1	4%
Production Charger	2.0	50%	1.9	45%	0.2	5%
Production Drilling	1.8	53%	1.5	43%	0.2	4%
Raise Driller	2.9	61%	1.7	36%	0.1	3%
Services	1.5	55%	1.1	39%	0.2	6%

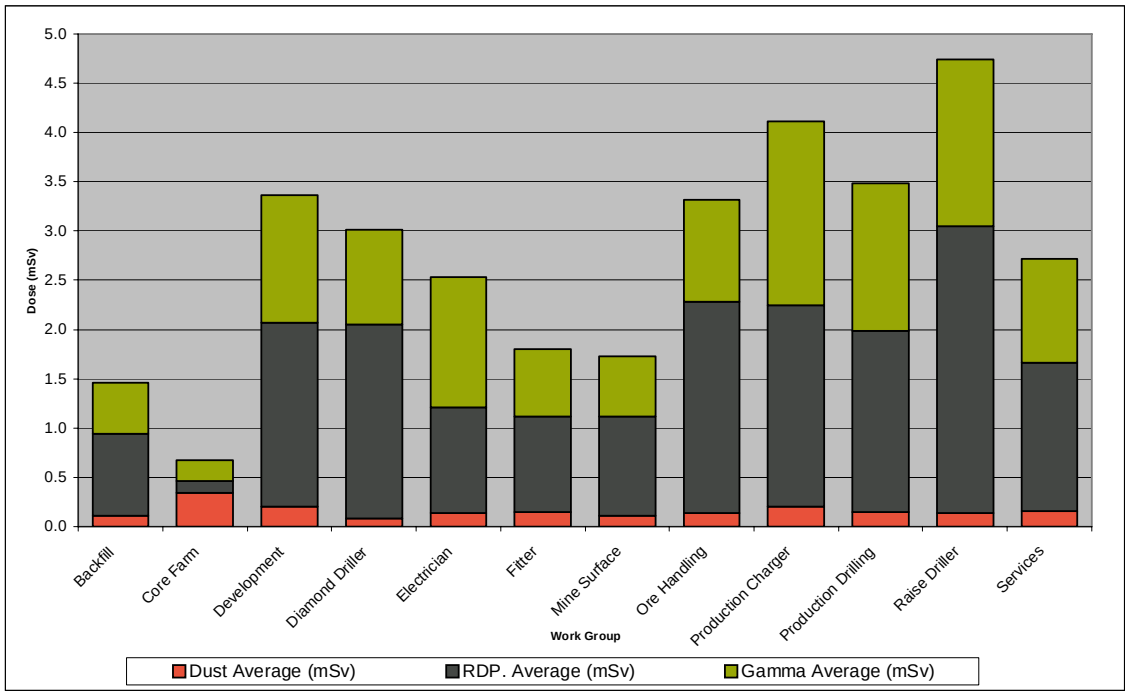


Figure 2 – Doses, showing components, for Full Time Designated Mine Employees

The average and maximum effective dose for the critical Mine underground workgroups and dose component trends for selected workgroups are given from Figure 3 - Figure 26.

Back Fill

The average dose to the Backfill workgroup has decreased from 1.7 mSv to 1.5 mSv whilst the maximum dose to this workgroup has increased from 1.9 mSv to 2.1 mSv. This reflects the transfer of Exact Mining employees who transfer from underground work to surface duties throughout the year.

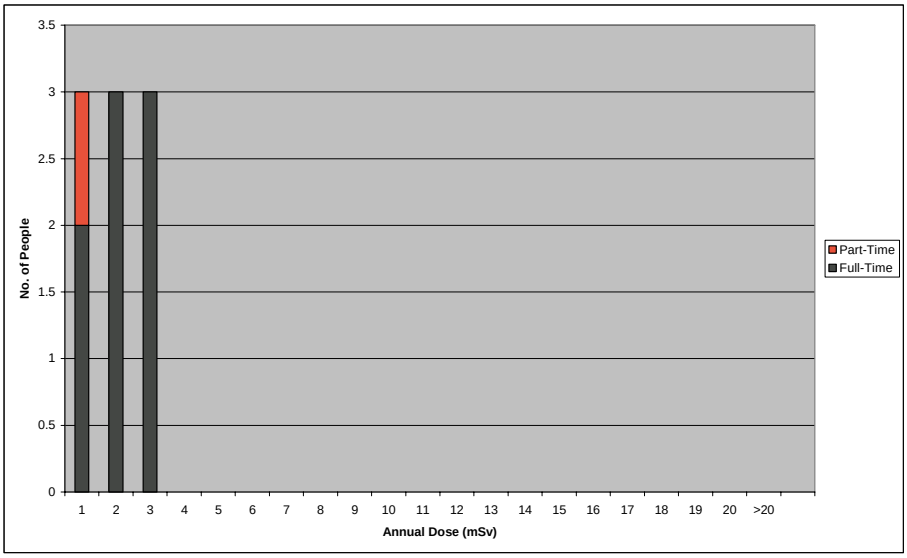


Figure 3 - Annual Dose Distribution for the Backfill Workgroup

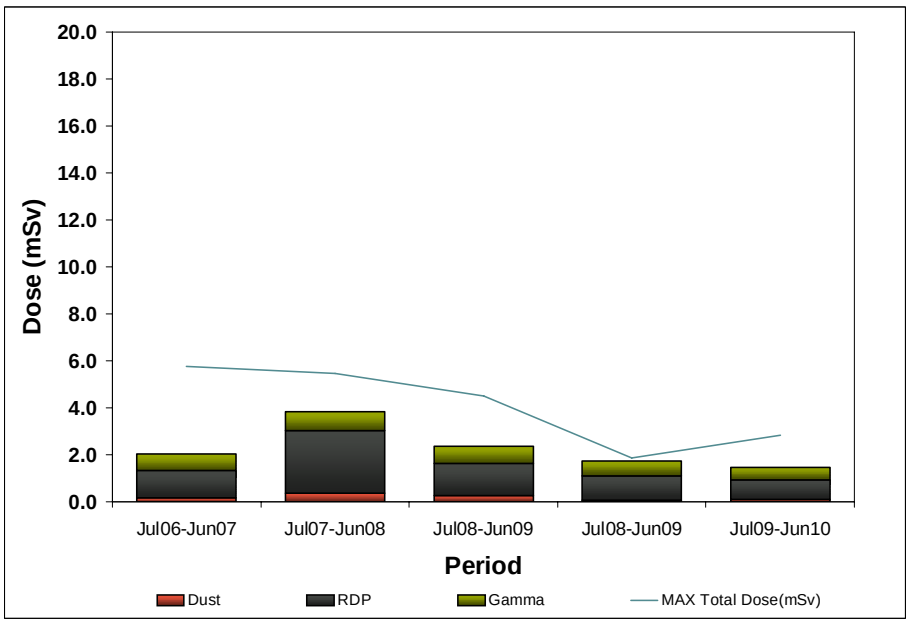


Figure 4 – Annual Dose Trends for the Backfill Workgroup

Core Processing

The average and maximum doses to Core Processing employees have remained at low levels of under 1mSv per year. Both average and maximum doses were 0.7 mSv. Dust exposure to this workgroup is in the process of review for occupational hygiene purposes.

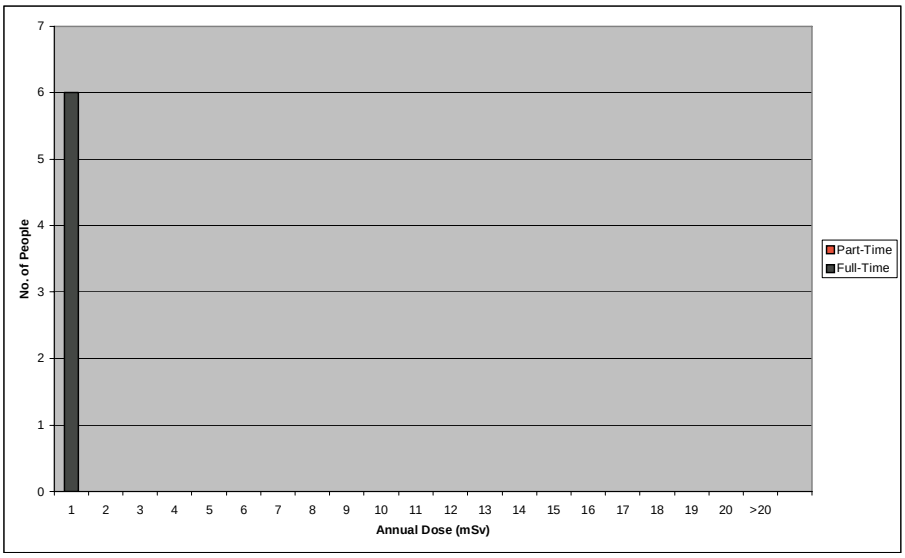


Figure 5 – Annual Dose Distribution for the Core Processing Workgroup

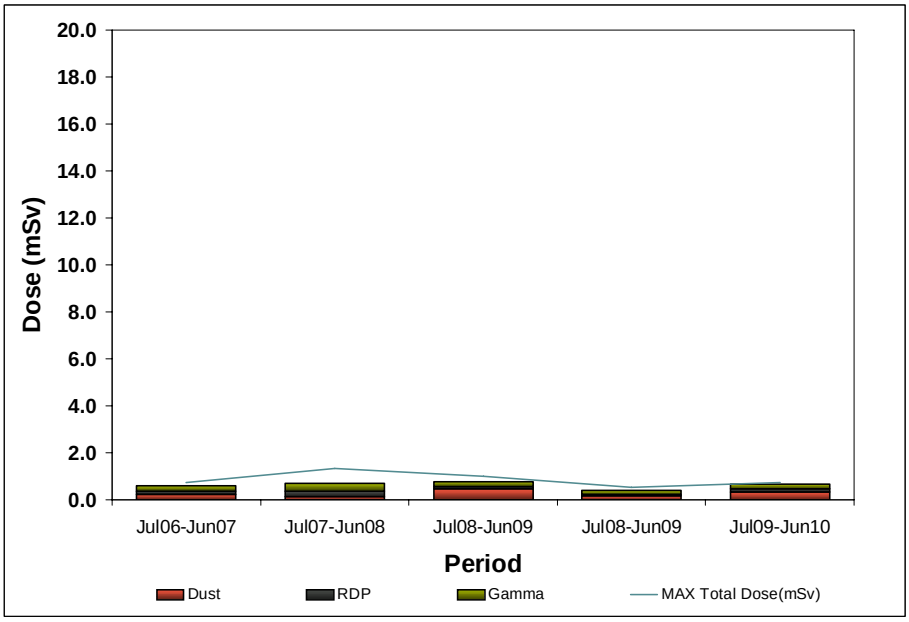


Figure 6 – Annual Dose Trends for the Core Farm Workgroup

Development

The average and maximum dose to the Development workgroup has decreased from 3.9 mSv and 6.3 mSv to 3.4 mSv and 5.3 mSv respectively. This is a result of reduced exposure to radon decay products and gamma.

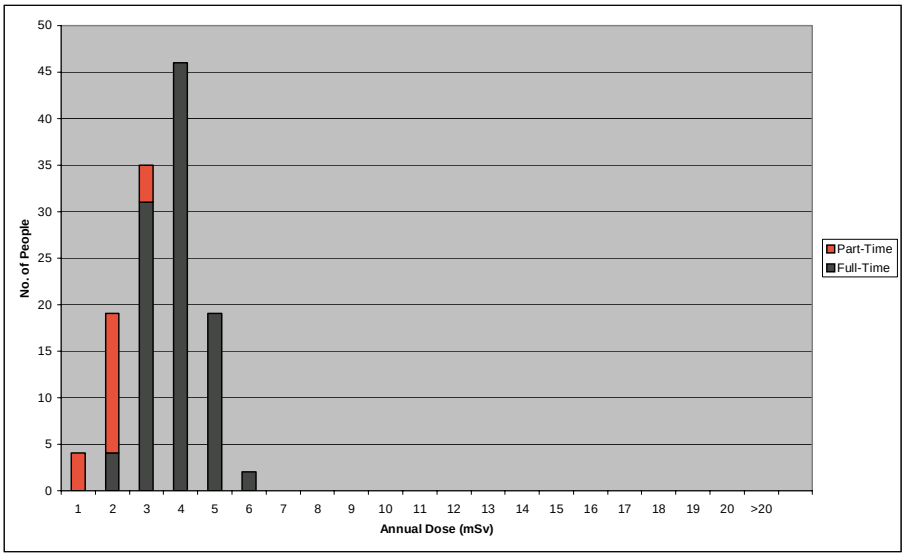


Figure 7 – Annual Dose Distribution for the Development Workgroup

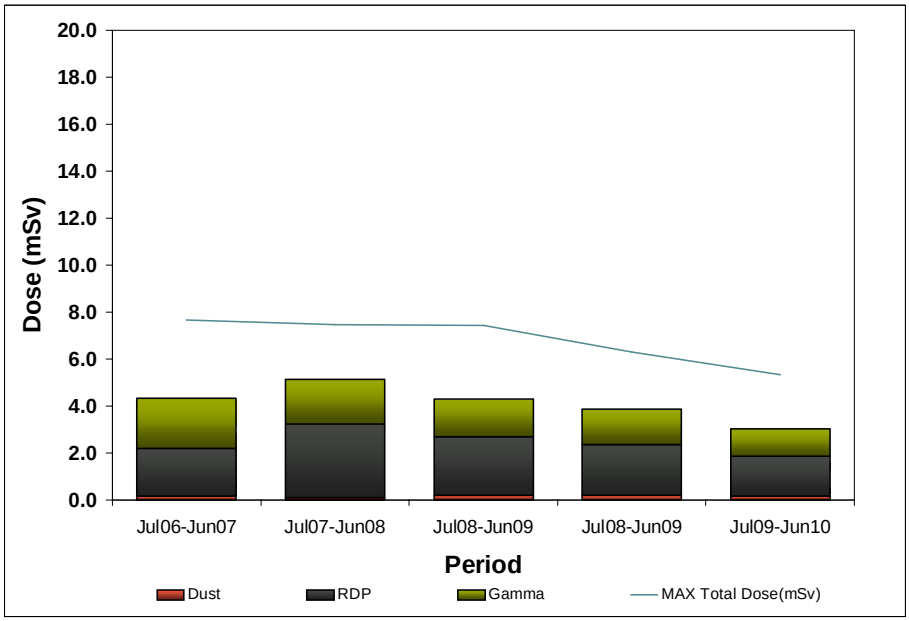


Figure 8 – Annual Dose Trends for the Development Workgroup

Diamond Drilling

The average and maximum dose to the Diamond Drilling workgroup has decreased from 3.3 mSv and 4.9 mSv to 3.0 mSv and 4.3 mSv respectively. The significant reduction in dose for this workgroup over the last few years is primarily a result of decreased gamma exposures with improved site set up. Radon decay product exposures to the workgroup have also reduced in the current reporting period and continue to be a focus for the workgroup.

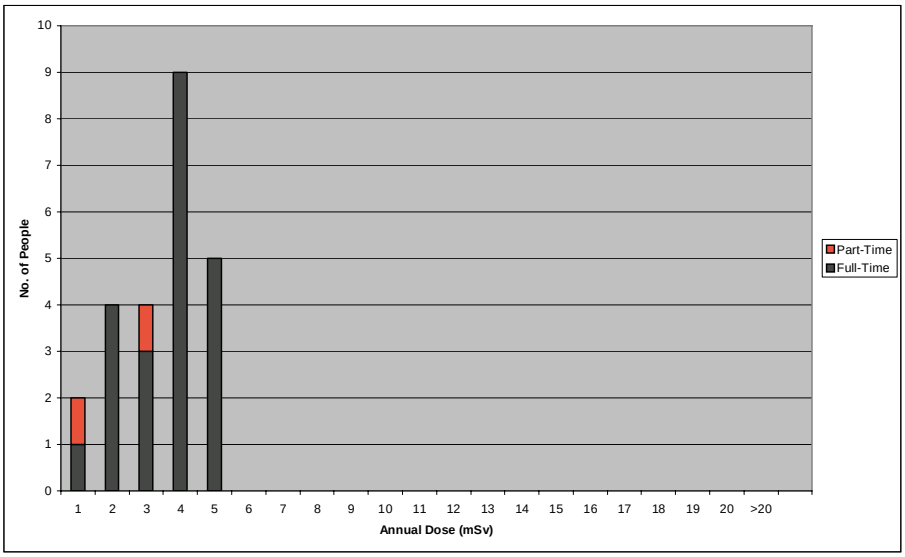


Figure 9 – Annual Dose Distribution for the Diamond Drilling Workgroup

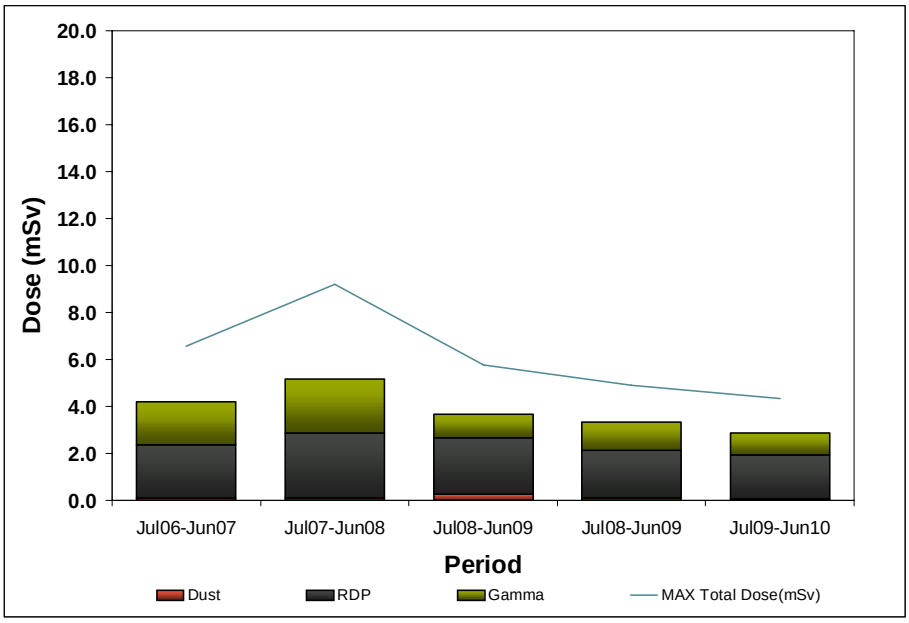


Figure 10 – Annual Dose Trends for the Diamond Drilling Workgroup

Electrician

The average dose to electricians has decreased slightly to 2.5 mSv while the maximum dose to this workgroup has increased from 2.6mSv in 2008/2009 to 5.6mSv. This increase for maximum exposure reflects the increased duration of time that contractor employees spent working underground.

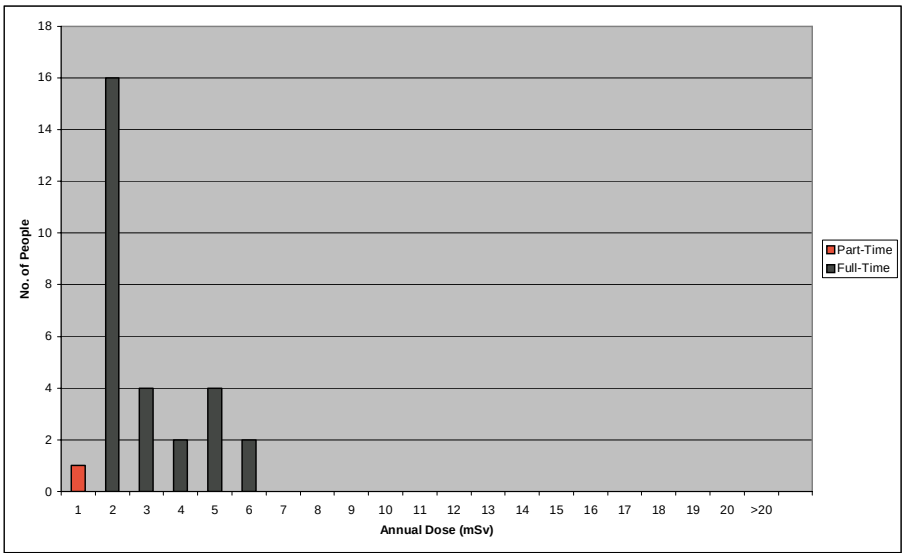


Figure 11 – Annual Dose Distribution for the Electrician Workgroup

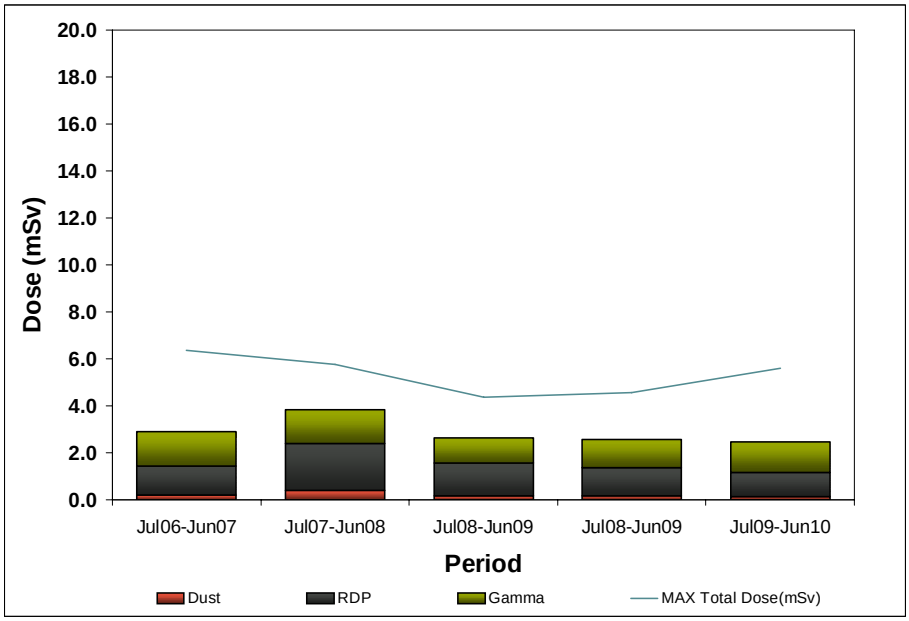


Figure 12 – Annual Dose Trends for the Electrician Workgroup

Fitter

The average dose to the Fitter workgroup has decreased from 2.0 mSv to 1.8 mSv whilst the maximum dose for Fitters has increased from 3.7 mSv to 4.1 mSv.

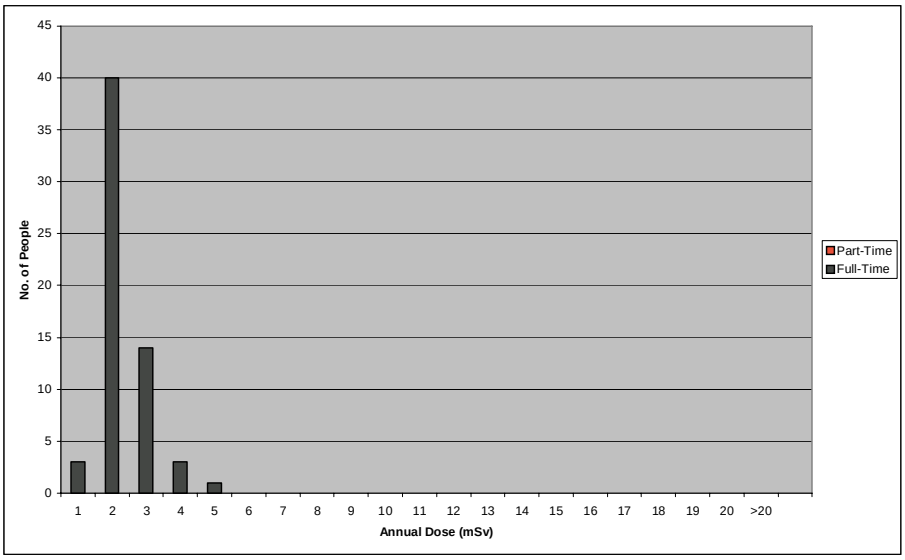


Figure 13 – Annual Dose Distribution for the Fitter Workgroup

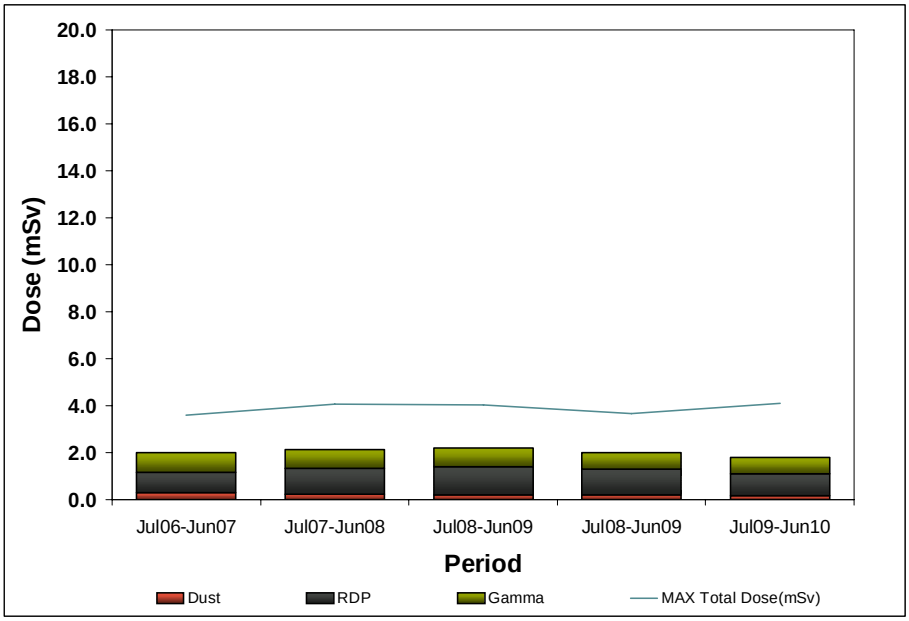


Figure 14 – Annual Dose Trends for the Fitter Workgroup

Surface Workers

The average dose has decreased from 1.8 mSv to 1.7 mSv and the maximum dose has reduced from 4.4 mSv to 3.6 mSv.

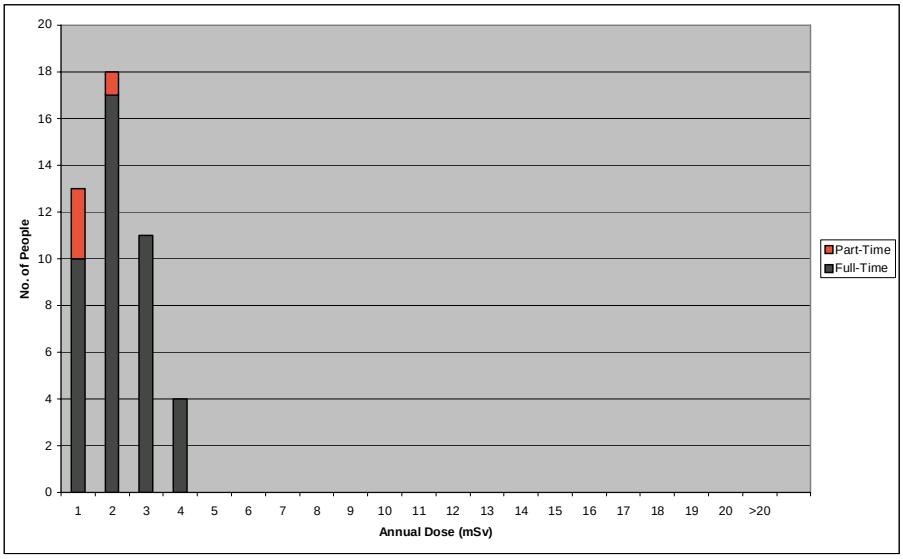


Figure 15 – Annual Dose Distribution for the Surface Workers Workgroup

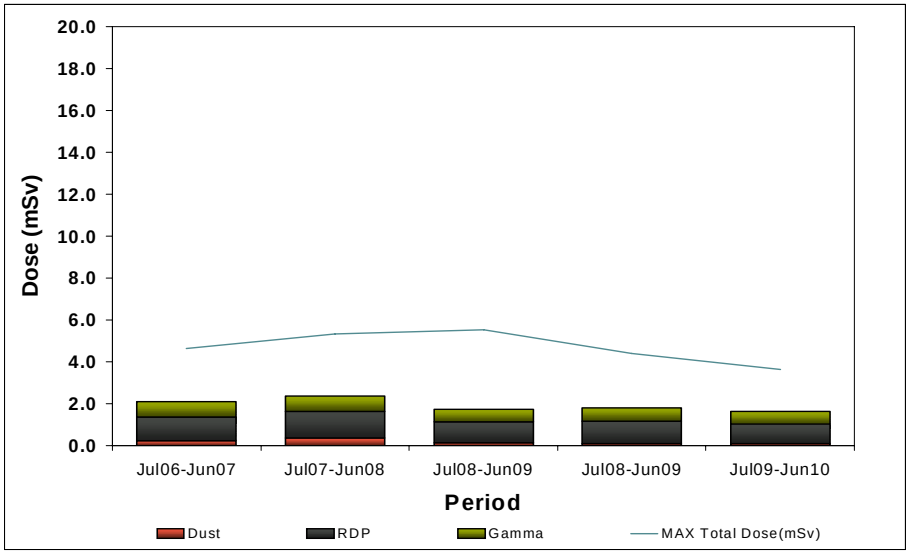


Figure 16 – Annual Dose Trends for the Surface Workers Workgroup

Ore Handling

The average dose has decreased from 3.8 mSv to 3.3 mSv while the maximum dose has also decreased from 6.9 mSv to 5.0 mSv. The decrease in the average dose is a result of minor decreases in radon decay product and gamma exposure. Average and maximum doses for the workgroup are still within historical levels.

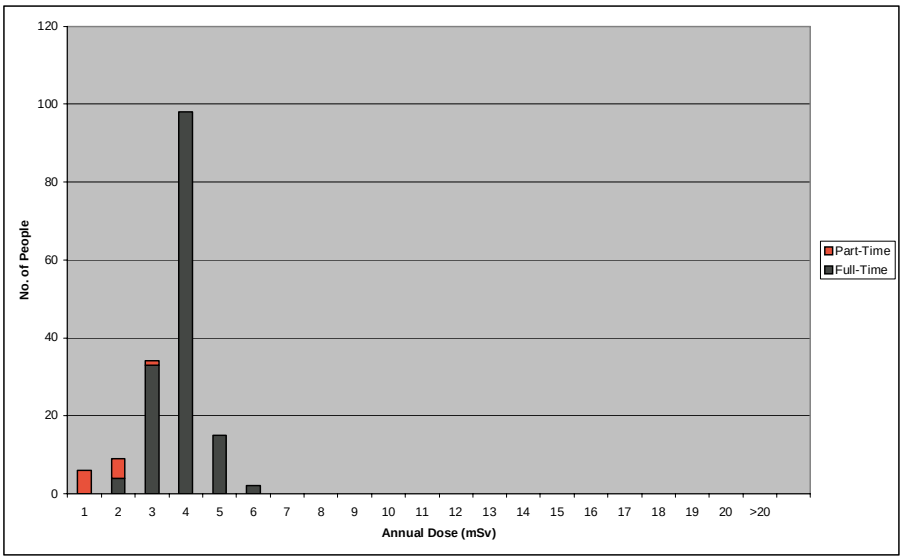


Figure 17 – Annual Dose Distribution for the Ore Handling Workgroup

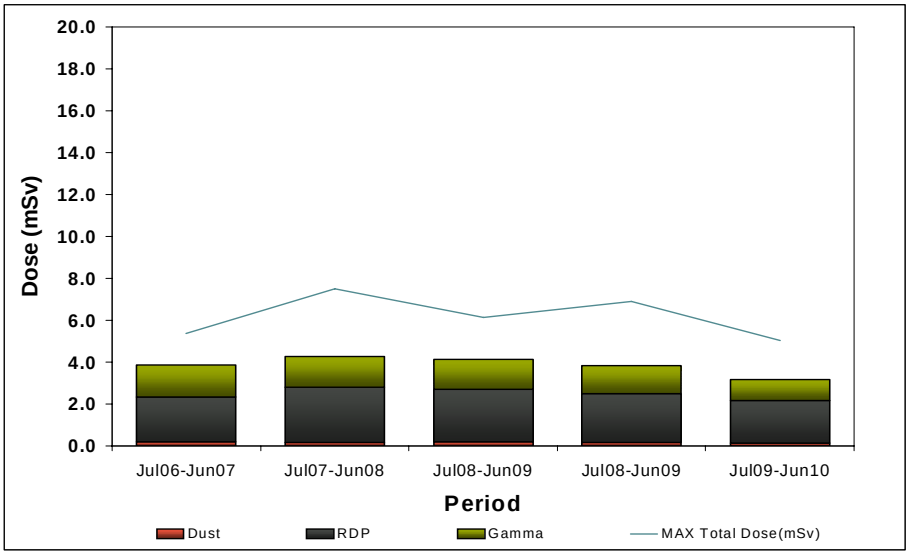


Figure 18 – Annual Dose Trends for the Ore Handling Workgroup

Production Charger

The average and maximum dose for Production Chargers have decreased from 4.7 mSv and 5.4 mSv to 4.1 mSv and 5.2 mSv respectively. The reduction is a result of a decrease in radon decay product exposure. Exposures remain within historical variations.

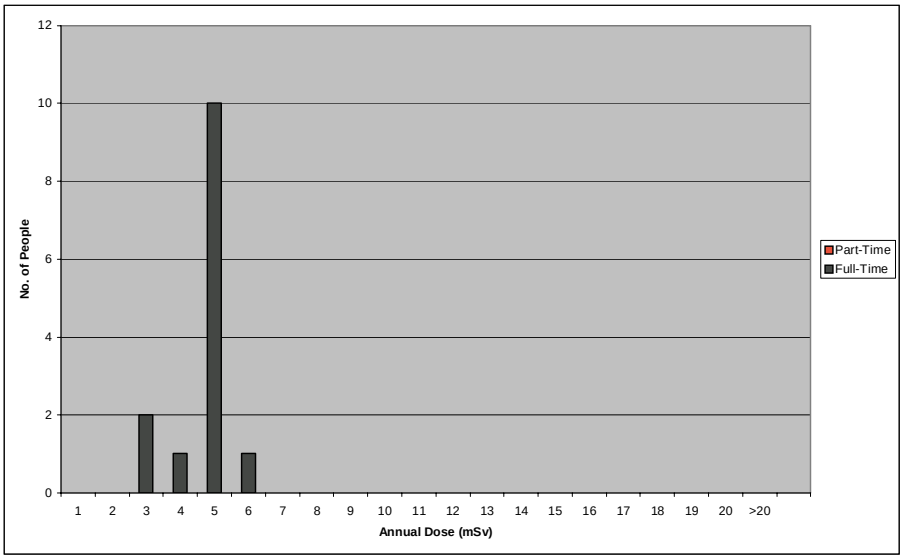


Figure 19 – Annual Dose Distribution for the Production Charger Workgroup

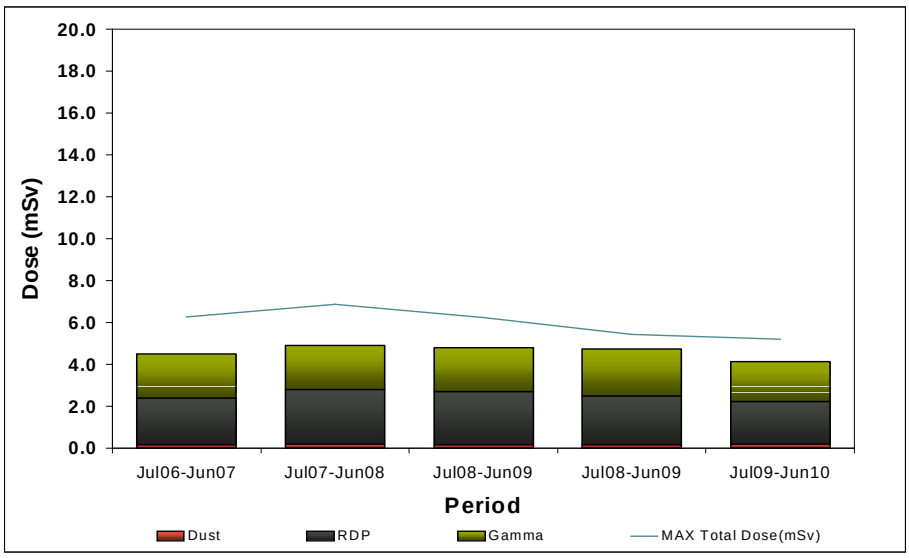


Figure 20 – Annual Dose Trends for the Production Charger Workgroup

Production Driller

The average dose for the production drillers has decreased from 3.8 mSv to 3.5 mSv and maximum dose increased from 6.3 mSv to 5.3 mSv. The reduction in the average exposure is due to a decrease in the radon decay product exposures. Exposures remain within the range of those experienced historically.

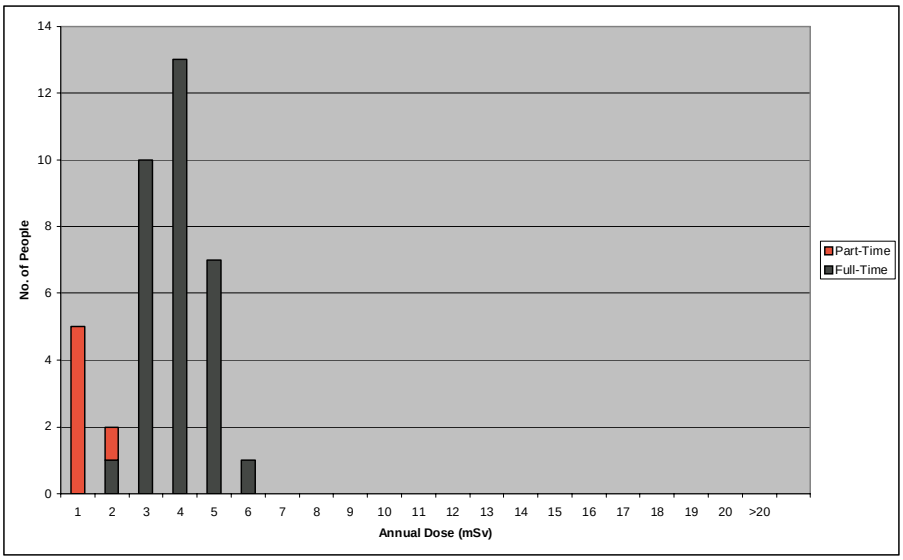


Figure 21 – Annual Dose Distribution for the Production Driller Workgroup

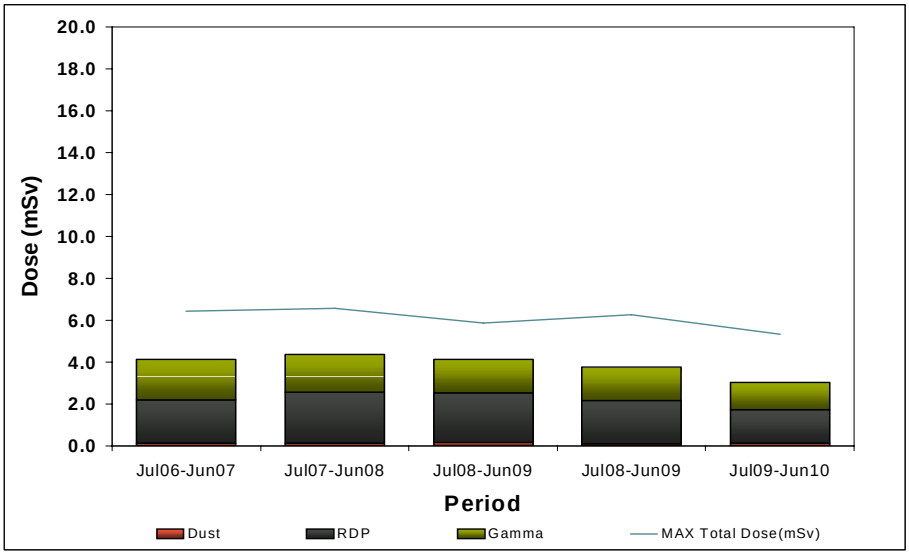


Figure 22 – Annual Dose Trends for the Production Driller Workgroup

Raise Driller

The average dose has decreased from 5.2 mSv to 4.7 mSv and the maximum dose has decreased from 7.8 mSv to 7.3 mSv. Focus on radon decay product exposure continues to be the main priority for radiation exposure to this workgroup.

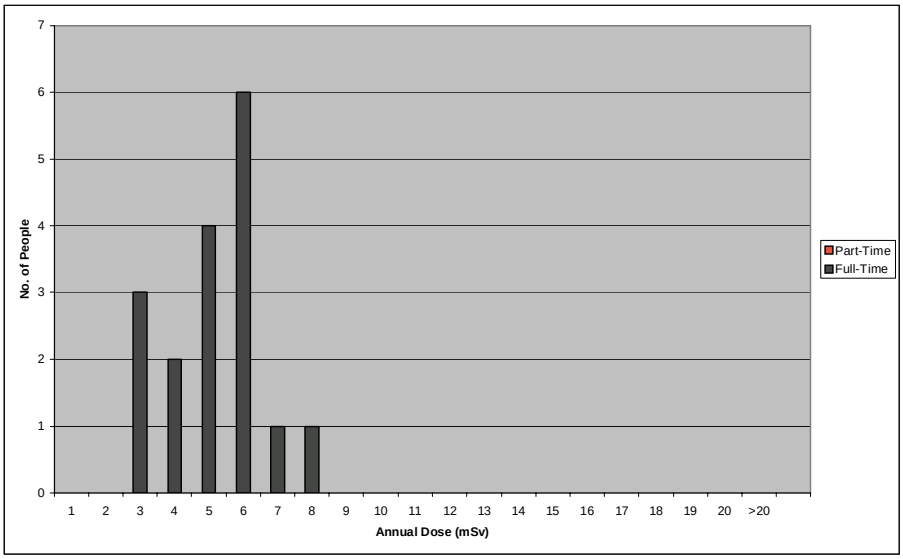


Figure 23 – Annual Dose Distribution for the Raise Driller Workgroup

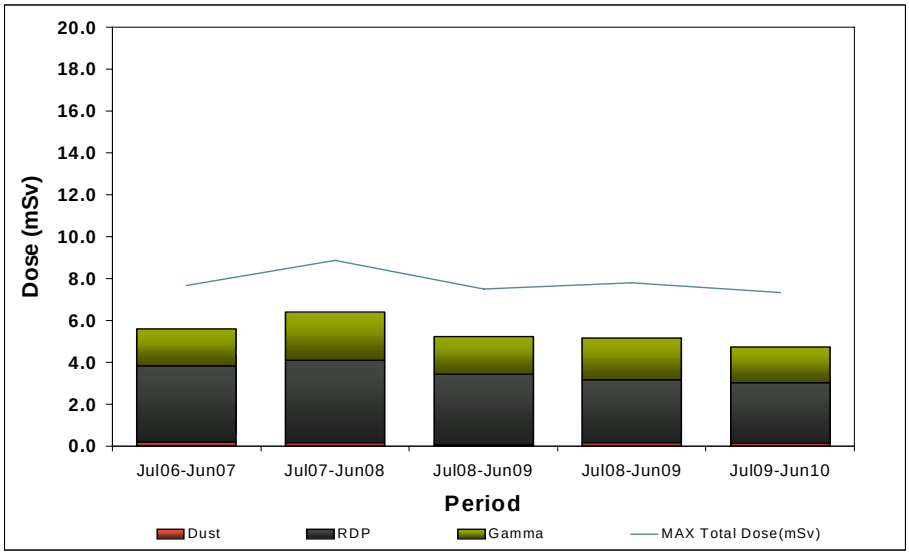


Figure 24 – Annual Dose Trends for the Raise Driller Workgroup

Underground services

The average dose has decreased from 3.3 mSv to 2.7 mSv and the maximum dose has decreased from 8.3 mSv to 5.4 mSv. This decrease in the maximum result reflects that the previous year the maximum employee had transferred from a Smelter workgroup and most of the exposure was from their work in the Smelter. The workgroup has seen a reduction in radon decay product exposure.

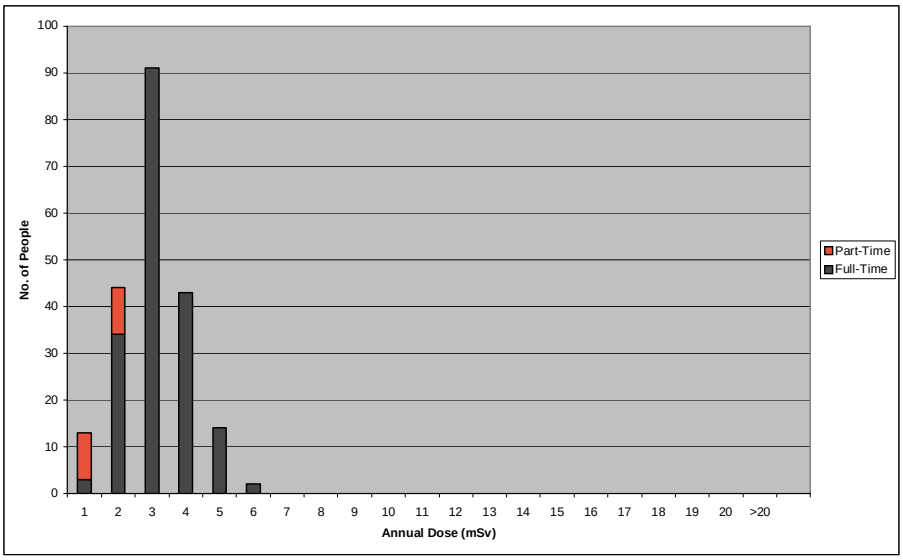


Figure 25 – Annual Dose Distribution for the Underground Services Workgroup

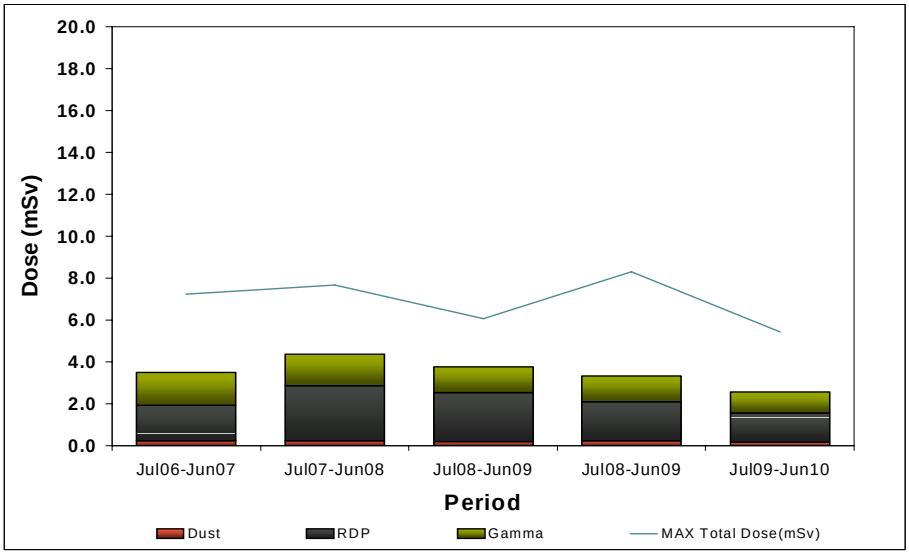


Figure 26 – Annual Dose Trends for the Underground Services Workgroup

3.1.3 Strategies for Dose Reduction

There is a continuous focus on reducing dose to employees at the mine and some of these measures include;

- Approval of the new Radiation Management Plan
- Implementation of continuous radon decay product monitoring equipment
- Continuing use of electronic gamma dosimeter monitoring program and a trial of new instrumentation
- Extensions to the existing ventilation system
- Focused radiation monitoring for the higher exposed work groups

The mine ventilation department have continued to focus on ensuring that exposure to radon decay products are minimised. This has been achieved through the following;

- Continued control over interactions in the mine through improvements in the 8 day and 3 month schedules
- The installation of the RB33 fans for additional air volumes for the Northern Rail and Cyan area is progressing and fans will be commissioned by March 2011
- The RB34 fans as an exhaust for the southern rail, CC and DSE sections of the mine have been commissioned
- RB31 intake has been extended down to the rail level (57-65 level) to cater for the exhausting of RB34
- Load sharing connection between the 45 Blues and 46 Green west area is underway. Once these areas connected extra air capacity will be given to the Blues area to improve conditions there.

An intensive program in the use of Bladewerx underground has found the instrument to be unreliable as a method of monitoring real time Radon Decay Product levels and the program has been abandoned. They will be transferred to the process plant and trialled in the Smelter for personnel real time Po-210 monitoring. It is planned to trial another radon decay product monitor already proven to work on other sites before the end of FY11. This will include a real time RDP monitoring analysis of two workgroups and a report back with control recommendations.

The Mine Radiation Team has focused on real time electronic gamma monitoring as well as general improvements to their operating systems over the last 12 months. This year has seen an increase in the utilisation of electronic gamma monitoring equipment both the dosicards and gamma watches.

3.1.4 Doses to Non-Designated Mine Employees

A dose distribution for non-designated employees and contractors at the Mine is listed in Figure 27. Non-designated employees are tracked individually on the same dose calculation system as the designated employees. A summary of all non-designated employee doses is given in Table C

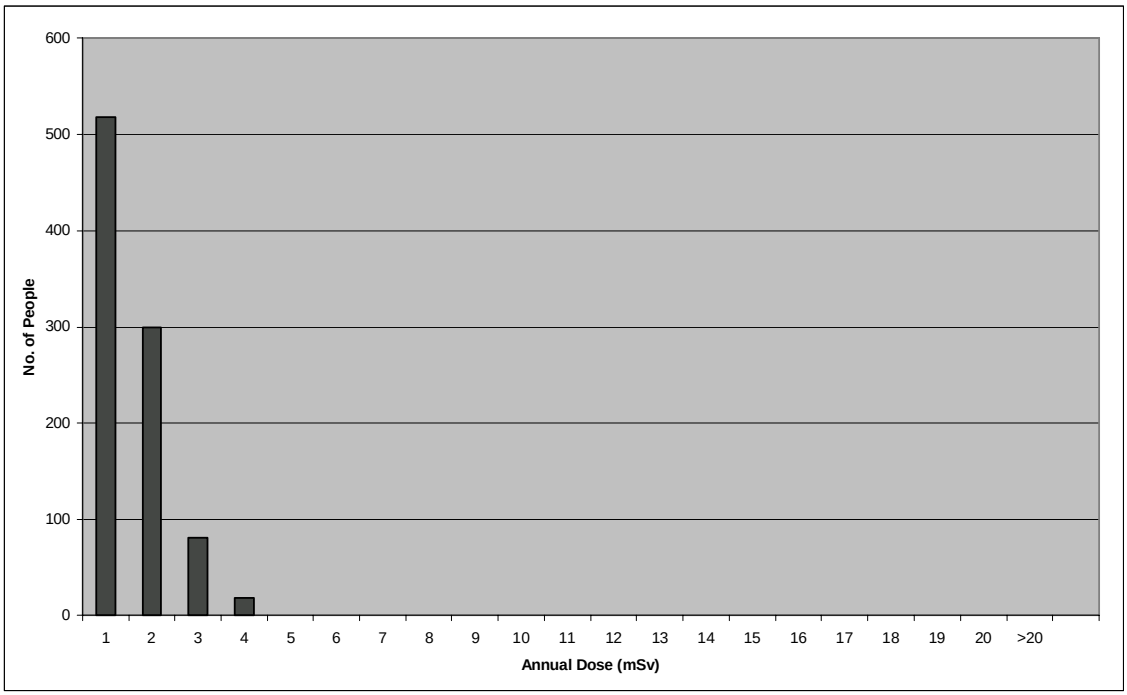


Figure 27 – Annual Dose Distribution for Non-Designated mine end employees

Table C – Non Designated Mine Employee Statistics

Statistics	Non Designated Employees
Count	917
Arithmetic Mean (mSv)	1.0
90th Percentile (mSv)	2.0
Min (mSv)	0.1
Max (mSv)	3.9
Mean % Dose from RDP	42%
Mean % Dose from Dust	13%
Mean % Dose from Gamma	45%

Maximum and average dose trends for all non-designated mine workers are presented in Figure 28 Figure 28 – Average Dose Trends for Non-Designated Employees.

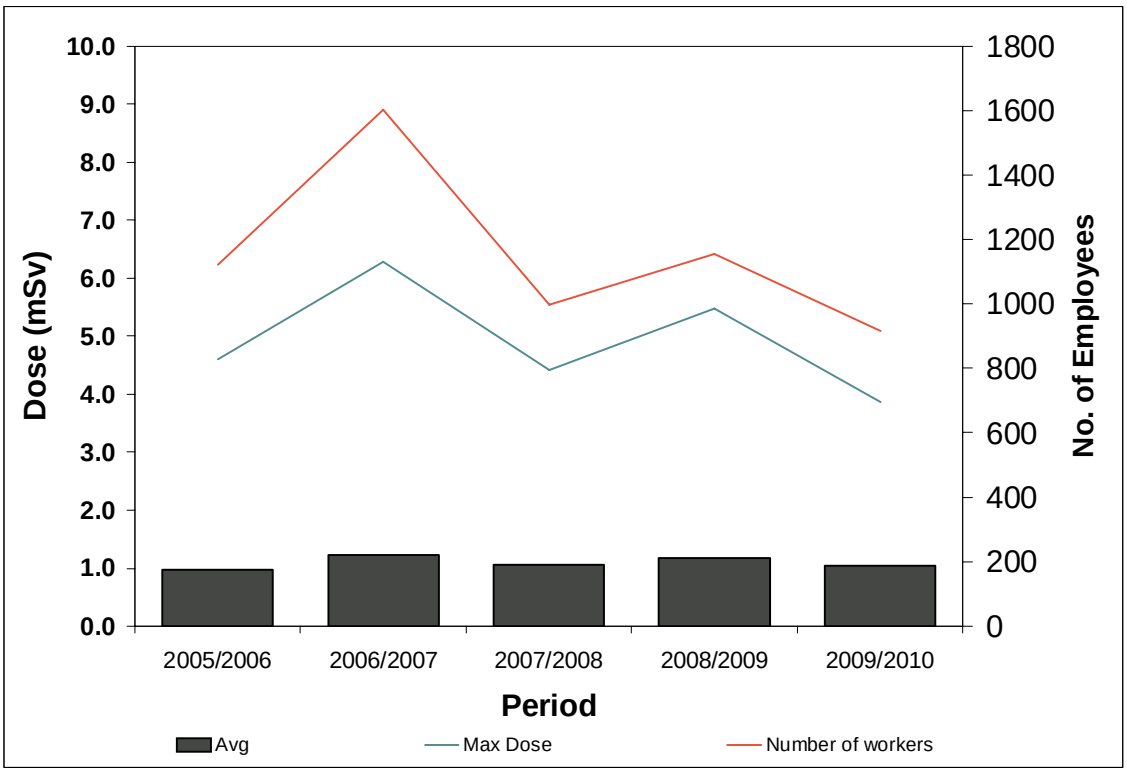


Figure 28 – Average Dose Trends for Non-Designated Employees

Airborne dust doses and radon decay product doses have been calculated using average airborne dust measurements, average radon decay product measurements, dose conversion factors and either an estimation of the hours worked based on a typical working roster, or actual hours. Gamma doses have been estimated based on direct personal monitoring and averages resulting from this monitoring.

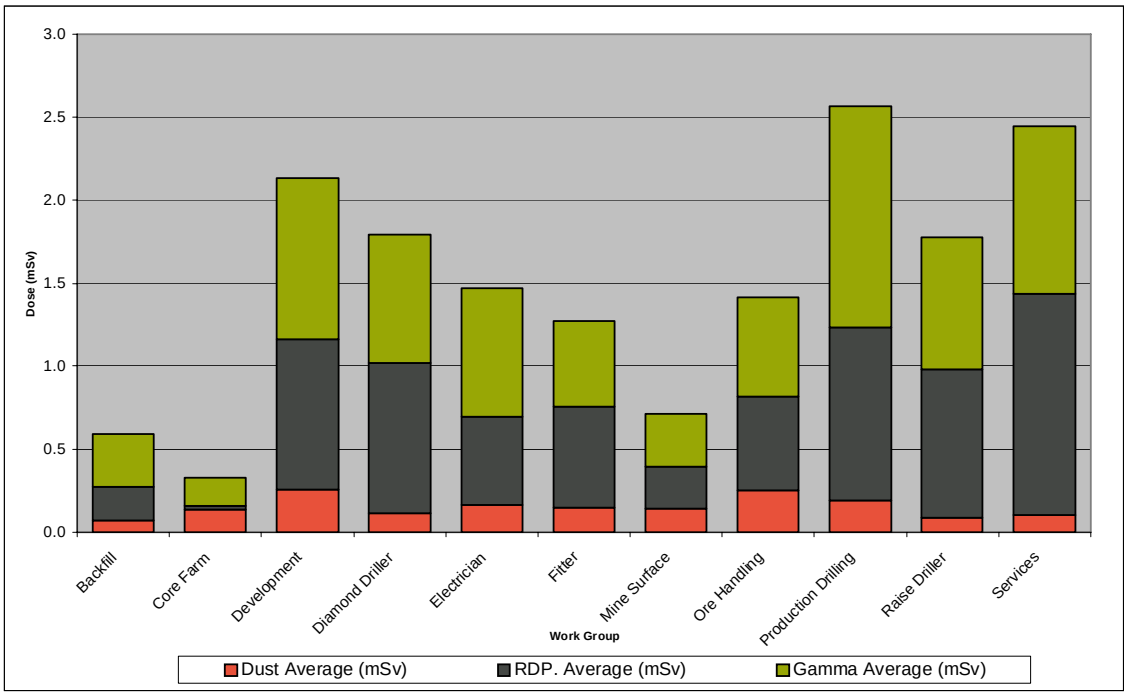


Figure 29 – Annual Doses for Non-Designated employees, by source and by Occupation

Figure 28 shows maximum and average dose trends for all non-designated Mine workers from 1 July 2005 to 30 June 2010.

The total number of non-designated employees has decreased from 1157 in 2008/2009 to 917 in 2009/2010. The average dose has decreased from 1.2 mSv to 1.0 mSv. Nineteen mine employees received a dose above 3 mSv, with the highest being 3.9 mSv. These employees have not been designated because they were recently engaged workers, have recently changed jobs or previously assessed as not needing to be designated.

3.1.5 Cumulative Five Year Dose

As outlined in ICRP 60, the total dose of any individual radiation worker should not exceed 100 mSv in any five year period. To this end, a five year total dose has been determined for all full-time currently designated Mine workers who were employed at Olympic Dam for the previous five years. The calculation of cumulative five year effective dose includes employees who have worked for more than 18 quarters.

There were a total of 471 designated Mine workers who worked continuously at the Mine during the period 1st July 2005 to 30th June 2010. This number has increased from the 393 workers reported for the period 1st July 2004 to 30th June 2009. The maximum dose for a Mine worker is 31.3 mSv for the five year period ending 30 June 2010, as compared with 33.4 mSv for the 2003/2004 to 2008/2009 five year dose period. The arithmetic mean for the group was 14.8 mSv, a decrease from 16.6 mSv for the five year dose period 2003/2004 to 2008/2009.

The number of employees who have continuously worked for five years at the Mine has continued to increase due to an increase in staffing in general over the last few years. The distribution of doses for the cumulative five year dose is shown in Figure 30.

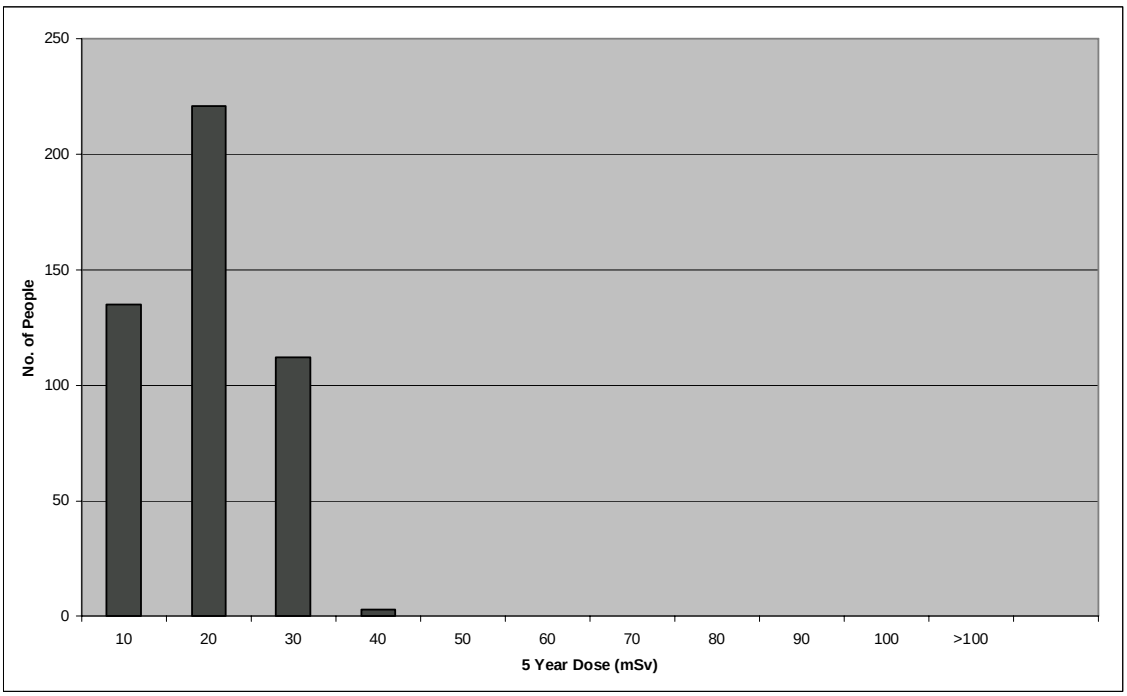


Figure 30 – Five Year Cumulative Dose Distribution Mine

A summary of the cumulative five year dose is given in Table D.

Table D – Five Year Stats

Statistics	Cumulative 5 year Doses	Equivalent Average yearly Dose
	For Continuously Employed Designated Mine Employees	
Count	471	471
Arithmetic Mean (mSv)	14.8	3.0
90th Percentile (mSv)	23.2	4.6
Min (mSv)	1.7	0.3
Max (mSv)	31.3	6.3
Mean % Dose from RDP	55%	
Mean % Dose from Dust	13%	
Mean % Dose from Gamma	39%	

3.2 Doses to Metallurgical Plant Employees

3.2.1 Descriptive Statistics

A total of 193 full-time designated Metallurgical Plant worker's doses were calculated for the period 1st July 2009 to 30th June 2010. This included most BHP Billiton Olympic Dam Metallurgical Plant employees and associated contractors who work full time in the plant.

In FY10 the Clark shaft which is responsible for supplying the majority of the ore to the plant suffered a failure and was out of service for approximately 7 months. The reduced ore availability allowed the Metallurgical Plant to be shutdown for extended periods to perform major maintenance. A highlight of this period was major smelter shutdown, which was originally scheduled for September 2010. The smelter was offline for approximately 4 months.

As a result of the extended shutdown, Metallurgical Plant doses (in particular the dust component) are significantly lower than normal operation as much of the exposure only occurs when the plant is operational. This had the biggest impact within the smelter area, where during the shutdown period, the dust activity concentration averaged less than 10% of the derived air concentration. Average quarterly doses during the shutdown period for all plant areas were below 0.5 mSv.

As a result of the Clark shaft incident only limited discussion of dose trends will occur in this report.

The mean dose to all designated plant employees was 1.4 mSv in 2009/2010, a decrease from the 2008/2009 value of 2.7 mSv.

The mean dose for full-time designated plant workers was 1.5 mSv in 2009/2010, a decrease from the 2008/2009 value of 3.0 mSv.

The mean dose for part-time designated plant workers was 0.8 mSv in 2009/2010, a decrease from the 2008/2009 value of 0.9 mSv.

For this period the distribution of doses is shown in Figure 31, and the statistics are given in Table E.

Table E – Statistics for designated employees, Metallurgical Plant

Statistics	Full-Time Designated Employees	Part-Time Designated Employees	All Designated Employees
Count	193	13	206
Arithmetic Mean (mSv)	1.5	0.8	1.4
90th Percentile (mSv)	2.6	1.6	2.5
Min (mSv)	0.1	0.1	0.1
Max (mSv)	3.6	2.5	3.6
Mean % Dose from RDP	10%	4%	10%
Mean % Dose from Dust	68%	78%	69%
Mean % Dose from Gamma	22%	17%	21%

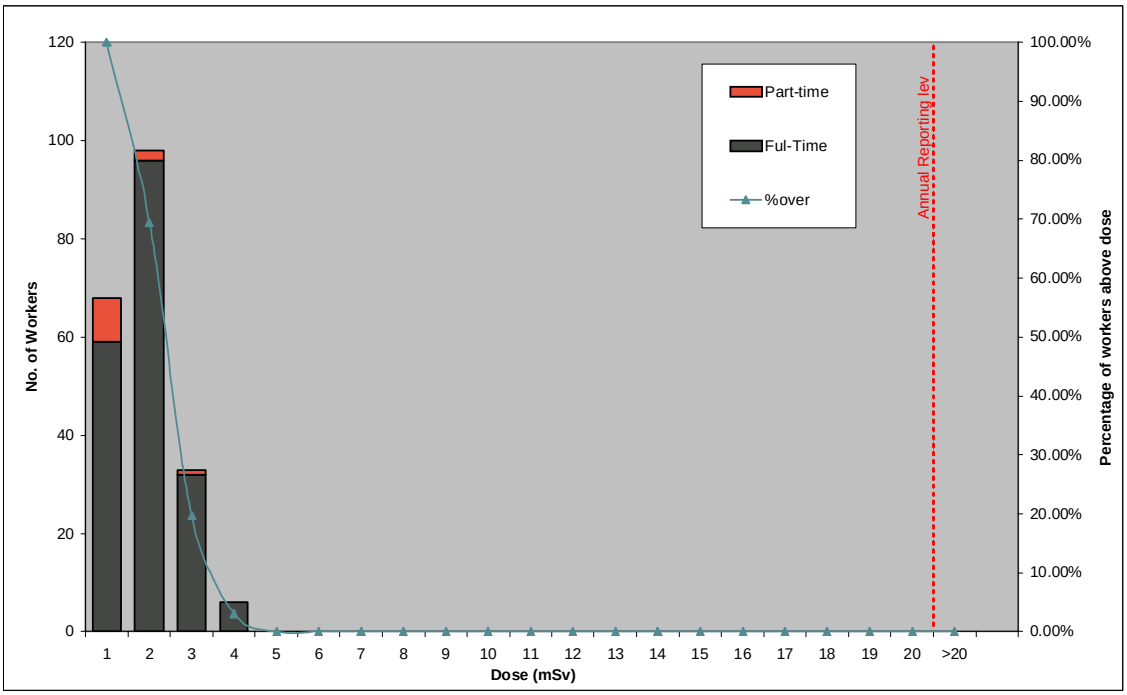


Figure 31 – Annual Dose Distribution for all Metallurgical Plant employees

3.2.2 Review of Doses by Work Areas

The analysis of doses by work area is presented in Table F. The dose statistics for the 2009/2010 year from the Metallurgical Plant areas show decrease in mean dose for all work groups except Concentrator and Services workgroups from the 2008/2009 year. Concentrator and Services mean remained constant. Maximum doses for all groups except for Services decreased.

Individual Work Areas

The highest levels were recorded in the Smelter workgroup. The smelter doses have significantly decreased as a result of better control of polonium 210 in the system and extended shutdown period. The number of full-time designated employees in the Metallurgical Plant has decreased from 208 in 2008/2009 to 193 in 2009/2010.

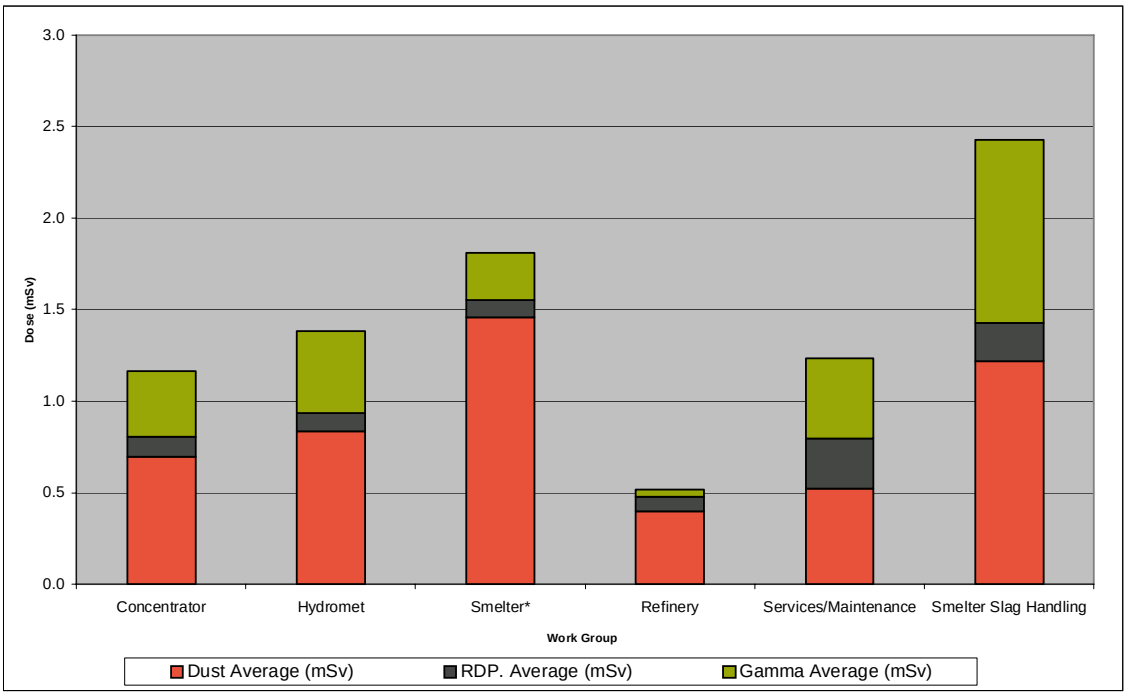
Annual dose components for each work area can be seen in Figure 31.

Table F - Annual Dose Statistics by Work Areas, Full-Time Designated Metallurgical Plant Employees

WORK CATEGORY	No. of Emp.	Mean (mSv)	Minimum (mSv)	Maximum (mSv)	90th Percentile (mSv)
Concentrator	17	1.2	0.9	1.9	1.3
Hydromet	12	1.4	0.6	2.7	1.8
Smelter*	92	1.8	0.6	3.6	2.9
Refinery	14	0.5	0.4	0.9	0.6
Services/Maintenance	58	1.2	0.1	3.0	2.1
Smelter Slag Handling	9	2.4	1.9	3.0	3.0

WORK CATEGORY	RDP. Average (mSv)	RDP. % of Total Dose	Gamma Average (mSv)	Gamma % of total Dose	Dust Average (mSv)	Dust % of Total Dose
Concentrator	0.11	9%	0.36	31%	0.70	60%
Hydromet	0.10	7%	0.45	32%	0.84	60%
Smelter*	0.09	5%	0.26	14%	1.46	81%
Refinery	0.08	16%	0.04	7%	0.40	77%
Services/Maintenance	0.27	22%	0.44	36%	0.52	42%
Smelter Slag Handling	0.21	9%	1.00	43%	1.22	52%

* Smelter work group also includes Slag handling workers



* Smelter work group also includes Slag handling workers

Figure 32 – Annual dose components by workgroup

Annual total dose distributions and dose trends for each work area along with dose component profiles for selected workgroups can be seen in Figure 33 to Figure 42.

Concentrator

Concentrator doses remained similar to previous reporting year as process material (source of exposure) remains in the plant regardless of operation.

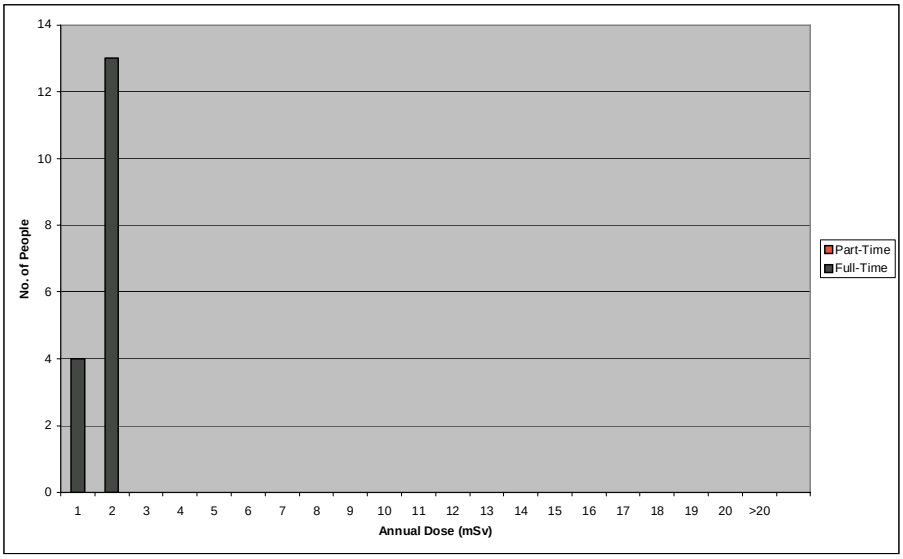


Figure 33 – Annual Dose Distribution for the Concentrator Workgroup

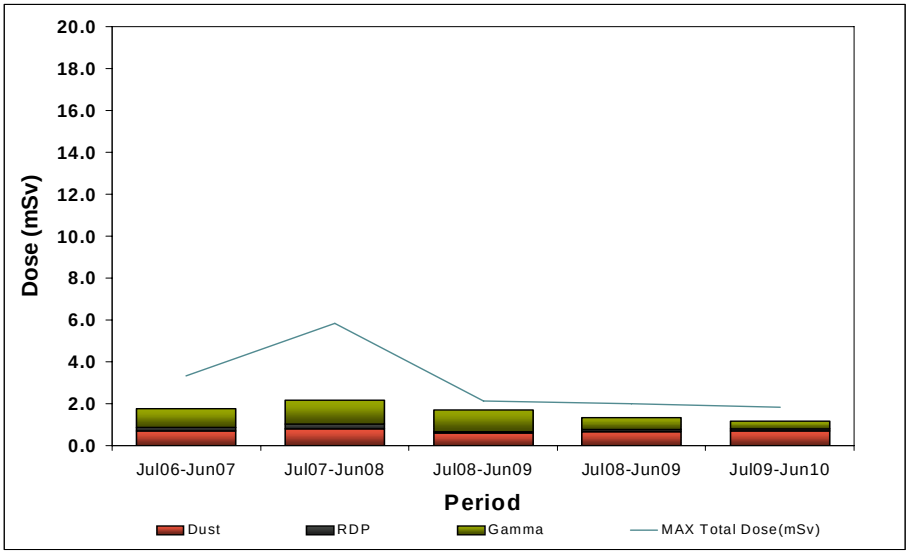


Figure 34 – Dose Trends for the Concentrator Workgroup

Hydromet

The average dose for Hydromet workers decreased this reporting period. The main driver was the lower quantity of uranium produced, which resulted in lower dust and gamma exposures in the precipitation and calciner areas.

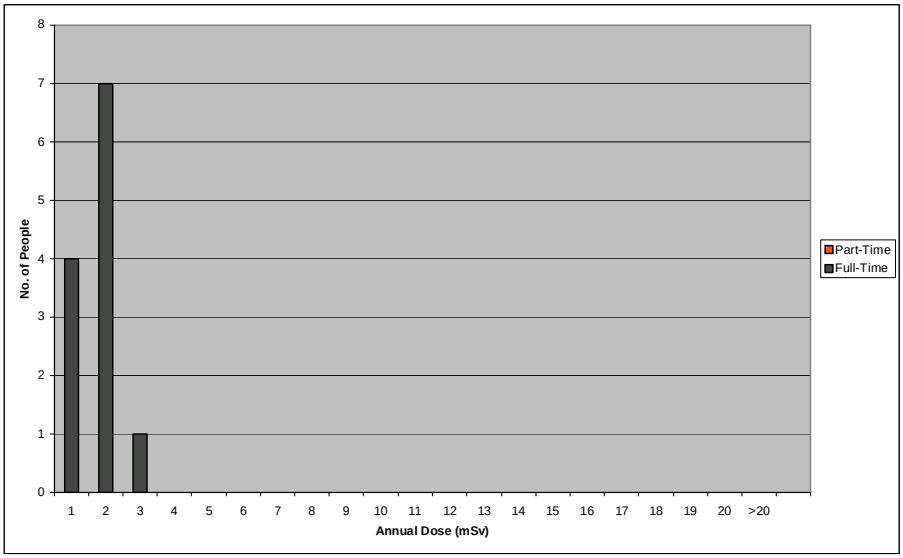


Figure 35 – Annual Dose Distribution for the Hydromet Workgroup

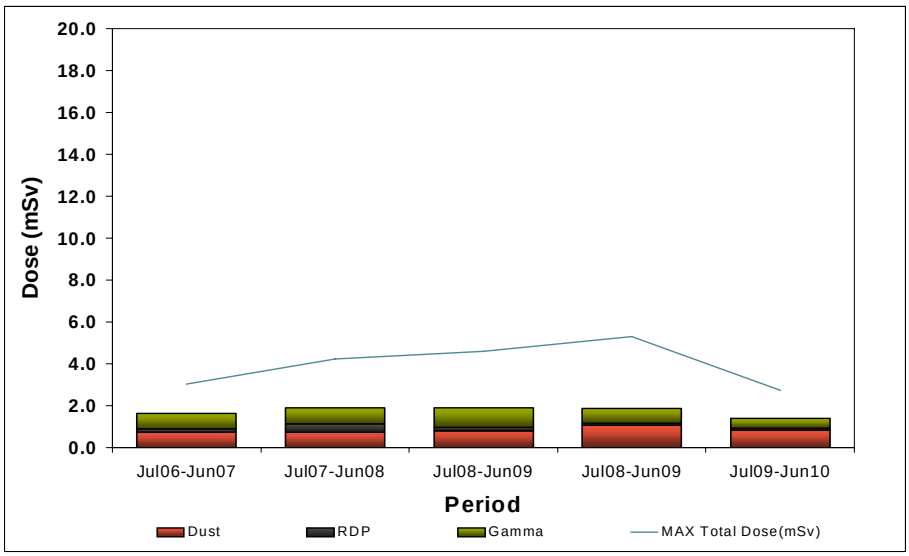


Figure 36 – Dose Trends for the Hydromet Workgroup

Smelter

Average doses in the smelter decreased to 1.8 mSv from 4.3 mSv. Maximum dose significantly decreased from 13.1 mSv to 3.6 mSv with the 90th percentile dose decreasing to 2.9 mSv. Action commenced in the previous reporting period to reduce the above average airborne dust activity concentration that resulted from the Flash Furnace dust recycle trial. In July 2009 personal dust activity averages had returned to activity concentrations below 50% of Derived Air Concentration (DAC).

Between November 2009 and March 2010, the Smelter was shutdown for major maintenance. During this time the personal dust exposures averages remained at or below 10% of DAC as there was no source of fume present The Smelter resumed normal operation in late March 2010 and personal dust activity concentration has been maintained below 25% of DAC.

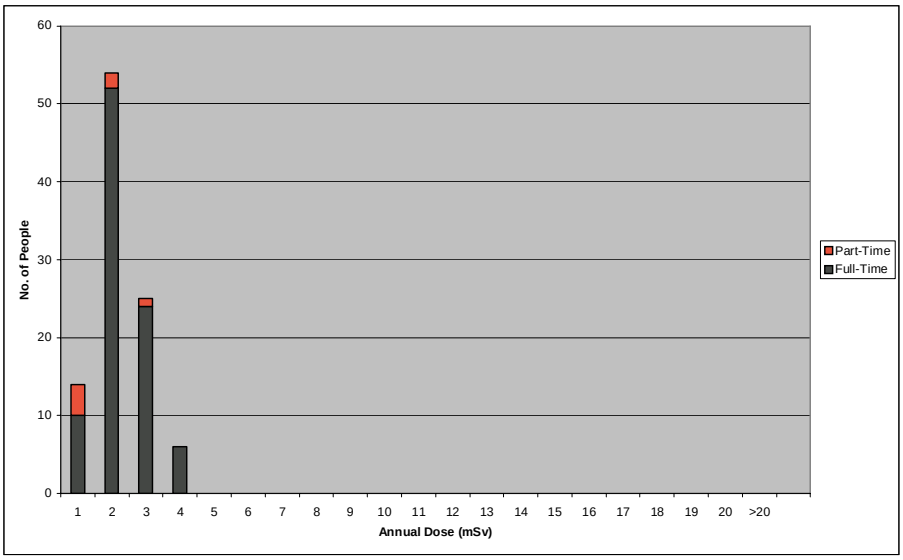


Figure 37 – Annual Dose Distribution for the Smelter Workgroup

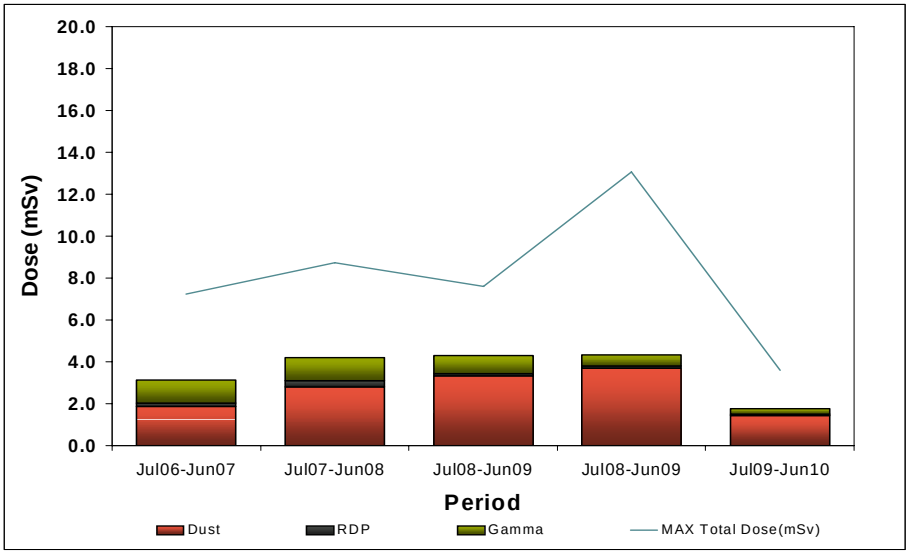


Figure 38 – Dose Trends for the Smelter Workgroup

Refinery

The Refinery workforce recorded the lowest maximum and annual average of any designated workgroup in the Metallurgical Plant, and remains at less than 1mSv.

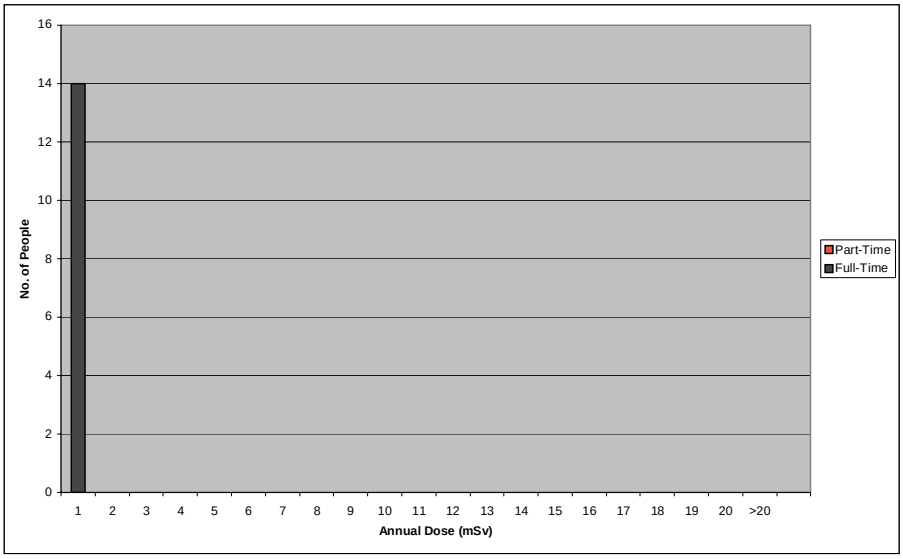


Figure 39 – Annual Dose Distribution for the Refinery Workgroup

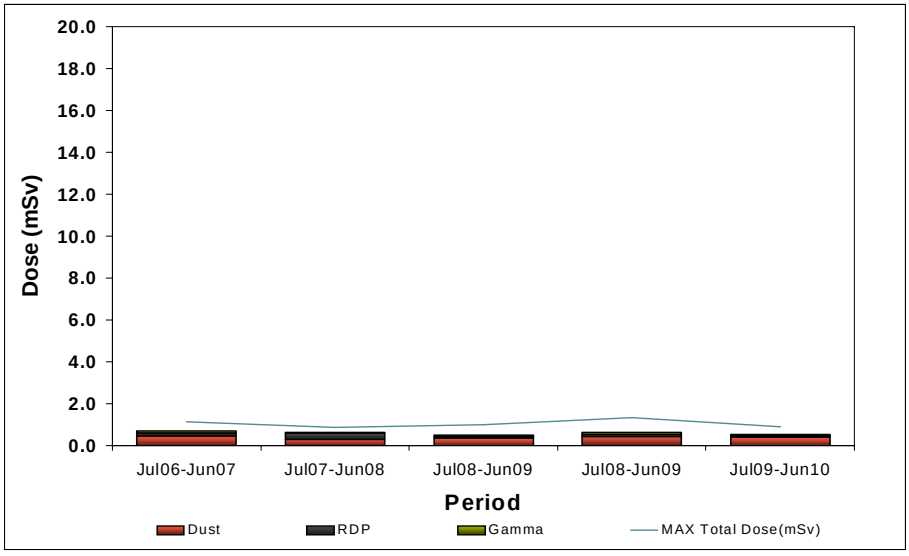


Figure 40 – Dose Trends for the Refinery Workgroup

Maintenance/ Services

The variable nature of the maximum dose is due to the fact that some of these personnel are spending time both underground and in the smelter building. The annual average dose remained at 1.2.

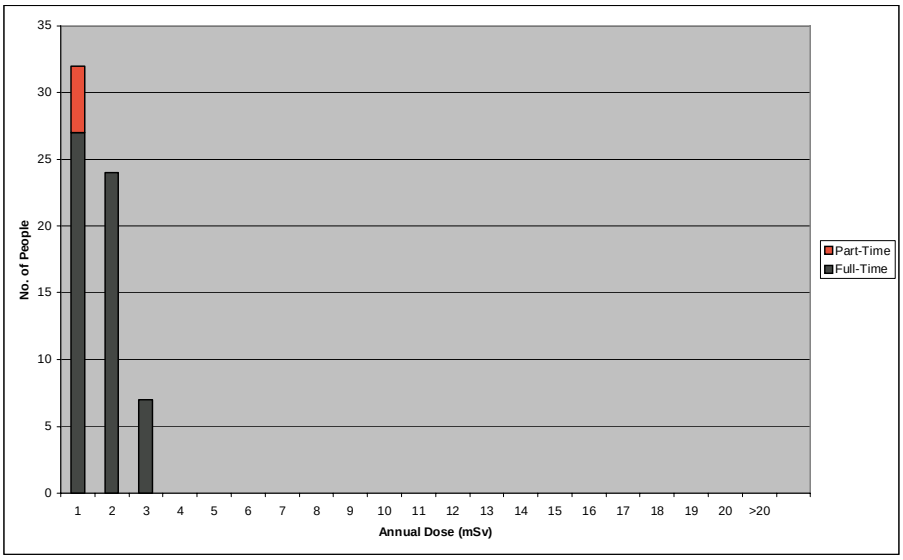


Figure 41 – Annual Dose Distribution for the Maintenance/Services Workgroup

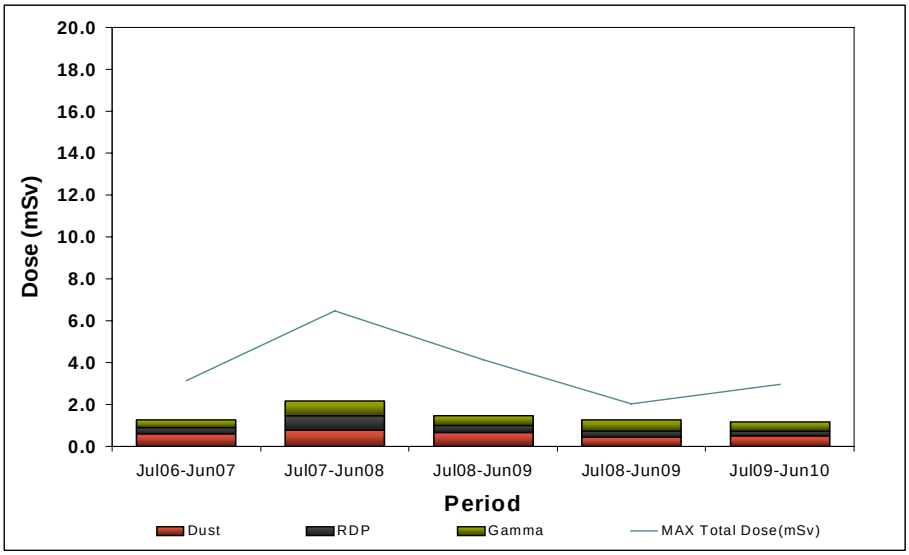


Figure 42 – Dose Trends for the Maintenance/Services Workgroup

Slag Handling

The average and maximum dose to the Slag Handling workgroup has decreased this reporting period in line with reduced plant output.

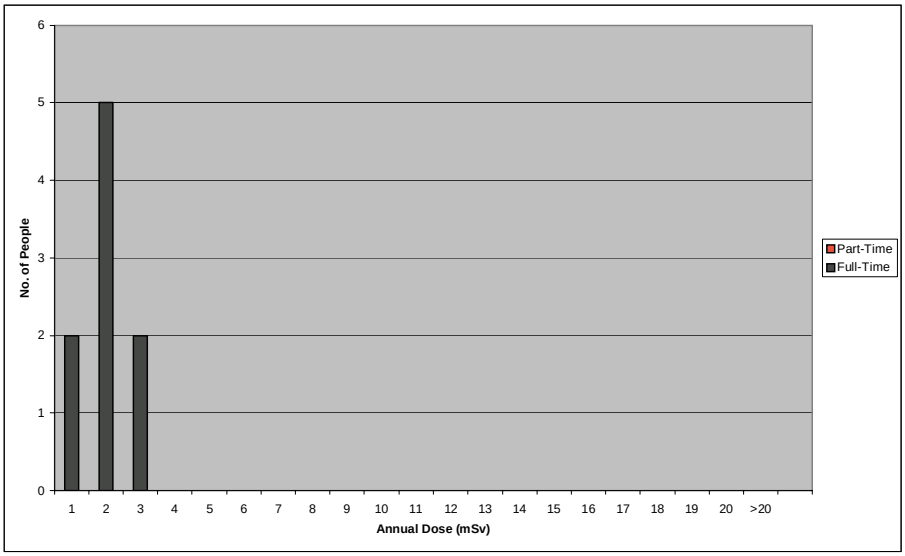


Figure 43 - Annual Dose Distribution for the Smelter Slag Handling Workgroup Dose Histogram

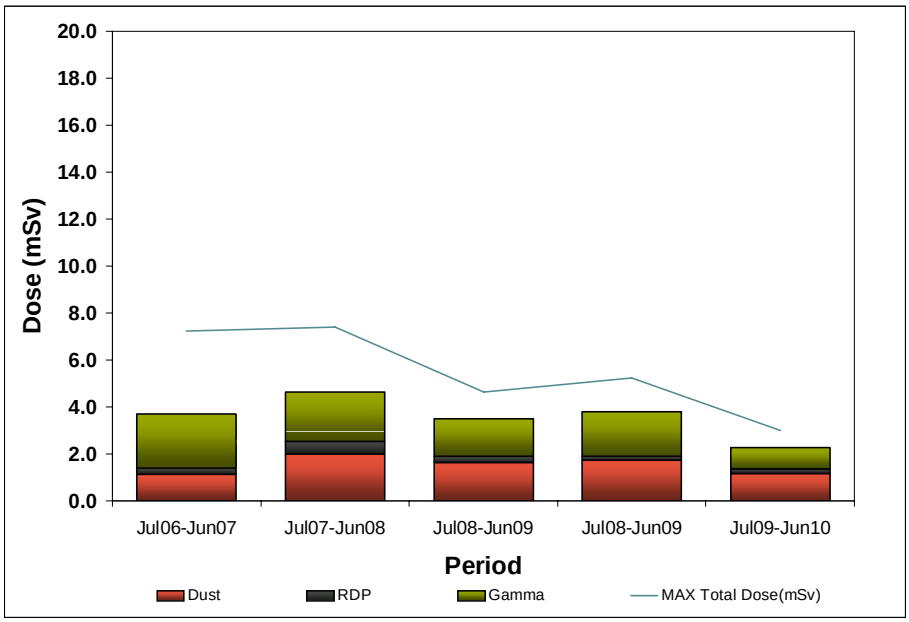


Figure 44 – Dose Trends for the Smelter Slag Handling Workgroup

3.2.3 Strategies for Dose Reduction

Significant work has been done by the Smelter team in controlling the polonium 210 within the Smelter systems to achieve the low doses during normal operations outside of the shutdown period. The experience gained during the Flash Furnace dust recycle trial in the previous year has resulted in a number of achievements. The smelter has run with increased dust recycle rates (improved copper gain, however increases Po210 activity of the dust) and improved dust leach efficiency (less Po210 gets returned to the smelter circuit). These achievements have been made whilst maintaining doses at the lowest levels seen in over 5 years (when looking at quarterly doses recorded outside of the shutdown period).

3.2.4 Doses to Non-Designated Employees

Doses to the most exposed non-designated Metallurgical Plant employees have been assessed. The current time/location system collects information from the majority of BHP Billiton Olympic Dam employees and contractors on site. Only a small fraction of these workers are designated. The rest are classified as non-designated workers, however, their doses are assessed using the same dose calculation system as for designated employees. A summary of dose statistics is given in Table G.

Table G – Non-Designated Employees Metallurgical plant, Dose Statistics

Statistics	Non Designated Employees
Count	2143
Arithmetic Mean (mSv)	0.7
90th Percentile (mSv)	1.4
Min (mSv)	0.1
Max (mSv)	3.4
Mean % Dose from RDP.	15%
Mean % Dose from Dust	55%
Mean % Dose from Gamma	30%

The total number of non-designated employees decreased from 2489 in the 2008/2009 year to 2143 in the 2009/2010 year.

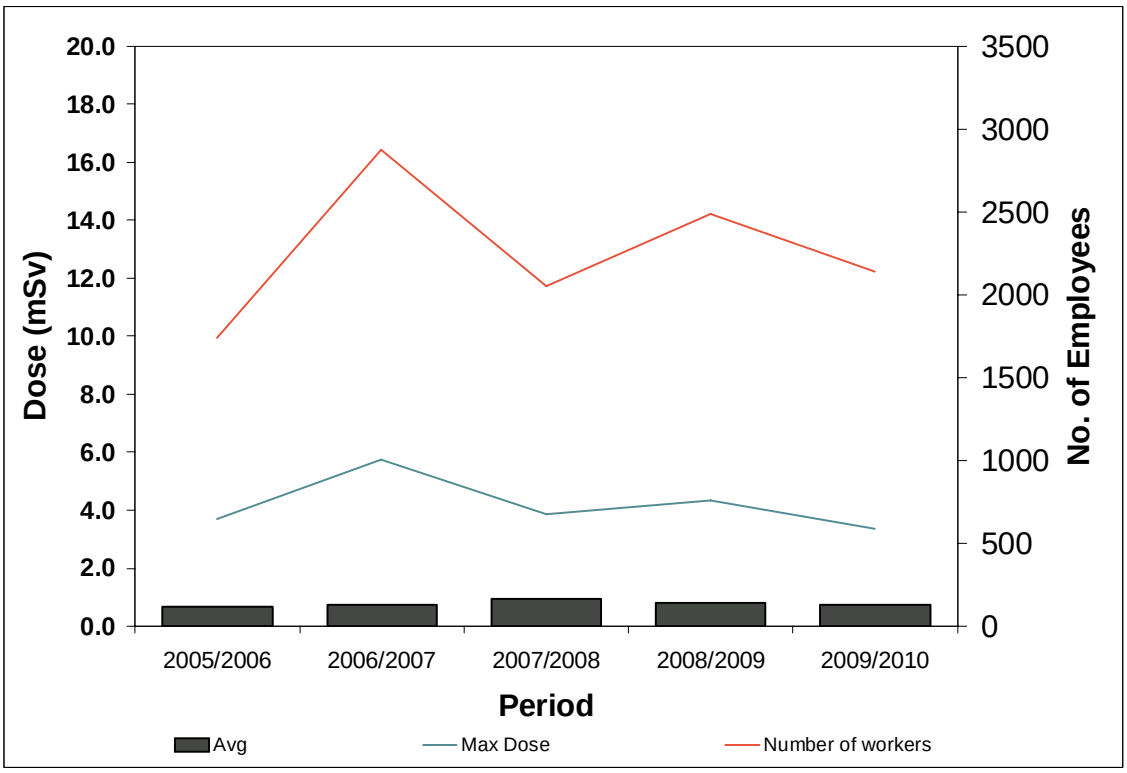


Figure 45 – Average Dose to Non-designated Metallurgical Plant Employees

The average dose has decreased to 0.7 mSv from 0.8 mSv in 2008/2009. The 90th percentile has also decreased slightly from 1.5 mSv to 1.4 mSv. The highest recorded dose for a non-designated employee was 3.4 mSv. This employee is a crane contractor who works across the surface and underground areas. This was the only non designated employee who recorded a dose over 3 mSv

The distribution of doses for 2009/2010 non-designated Metallurgical Plant employees is given in Figure 46.

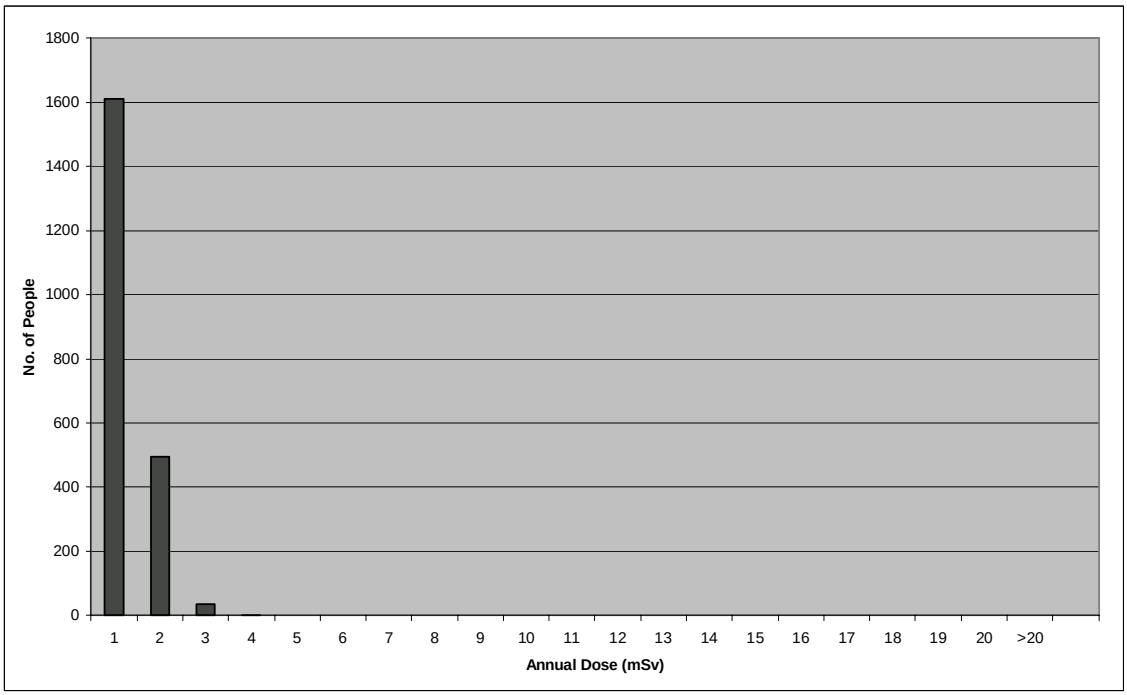


Figure 46 – Annual Dose Distribution for Non-designated process plant employees

Dose statistics for non-designated employees working in the Metallurgical Plant areas are shown in Table H and Figure 47.

Table H – Dose Statistics For non-designated Plant employees

WORK CATEGORY	No. of Emp.	Mean (mSv)	Minimum (mSv)	Maximum (mSv)	Standard Deviation (mSv)
Concentrator	168	1.0	0.3	2.3	0.4
Hydromet	96	1.1	0.3	3.4	0.5
Smelter	228	1.2	0.2	2.7	0.5
Refinery	114	0.6	0.2	1.3	0.2
Services/Maintenance	1537	0.6	0.1	2.6	0.4

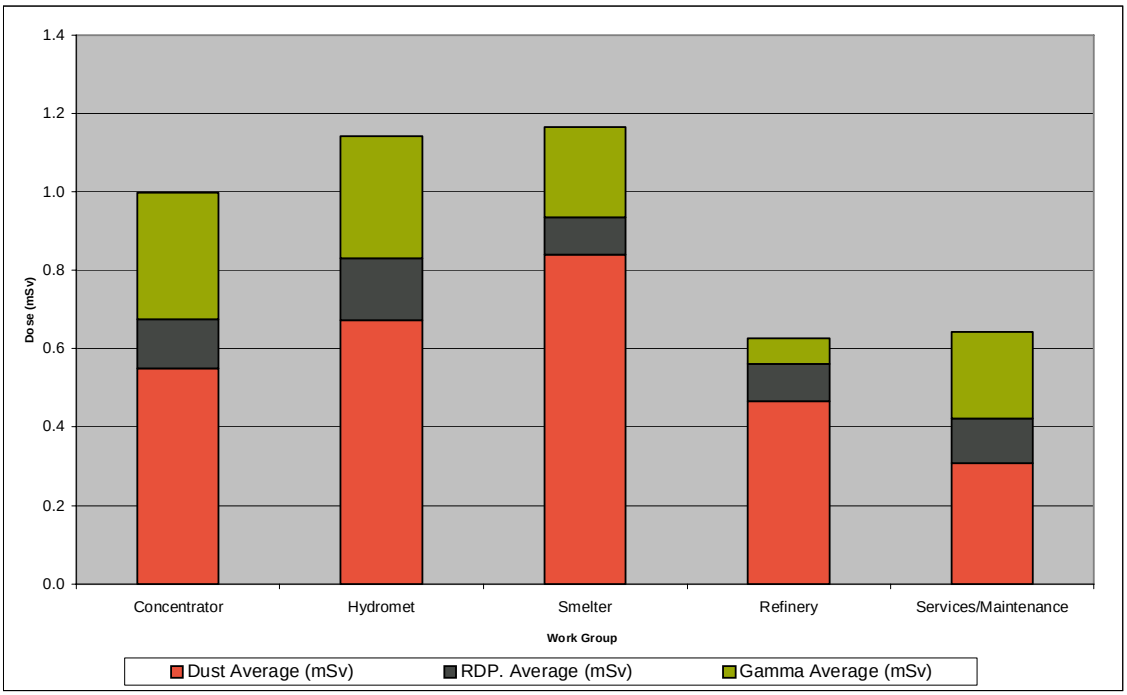


Figure 47 - Non Designated Process plant dose break-up, by workgroup

Airborne dust doses and radon decay product doses have been calculated using average airborne dust measurements, average positional radon decay product measurements and the relevant dose conversion factors. Gamma doses have been estimated based on direct personal monitoring and averages resulting from this monitoring. Hours are recorded by actual hours as recorded by Prodtrak, SAP, and the Cardax system. The Refinery and services/maintenance workgroups continued to record an average dose below 1 mSv during 2009/2010.

3.2.5 Cumulative Five Year Dose

As outlined in ICRP 60, the total dose of any individual radiation worker should not exceed 100 mSv in any five year period. To this end, a five year total dose has been determined for all Metallurgical Plant employees who were employed at BHP Billiton Olympic Dam for the previous five years. Designated employees who have worked for more than 18 quarters are included in this analysis.

There were a total of 371 currently designated Metallurgical Plant employees who worked continuously at Olympic Dam during the period 1st July 2005 to 30th June 2010.

The maximum dose for the five year period was 32.4 mSv, compared to the value of 41.7 mSv calculated in 2008/2009. The arithmetic mean for the five year dose period for the Metallurgical Plant has decreased from 10.4 mSv to 8.3 mSv. The distribution of doses for the cumulative five year dose is shown in Figure 48.

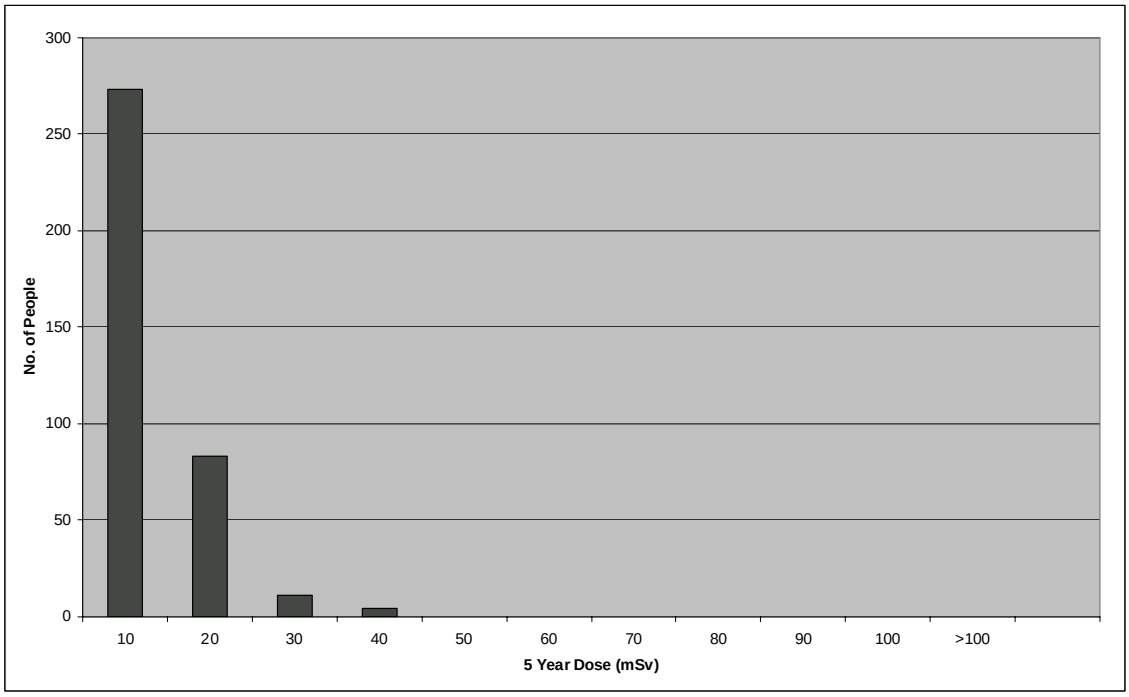


Figure 48 – 5 Year Cumulative Dose Distribution for Process Plant Employees

A summary of the cumulative five year dose is given in the Table below

Table I – Five Year Dose Statistics

Statistics	Cumulative 5 year Doses	Equivalent Average yearly Dose
	For Continuously Employed Designated Plant Employee	
Count	371	371
Arithmetic Mean (mSv)	8.3	1.7
90th Percentile (mSv)	16.5	3.3
Min (mSv)	2.4	0.5
Max (mSv)	32.4	6.5
Mean % Dose from RDP	13%	
Mean % Dose from Dust	67%	
Mean % Dose from Gamma	31%	

3.3 Annual Dose Trends

The average total effective dose to all designated employees at the Mine and Metallurgical Plant since 2004/2005 are shown in Figure 49 and Figure 50 respectively. The annual dose for the last year has been dominated by radon decay product exposure in the Mine and by dust exposure in the Process Plant, in particular, due to polonium-210 in the Smelter.

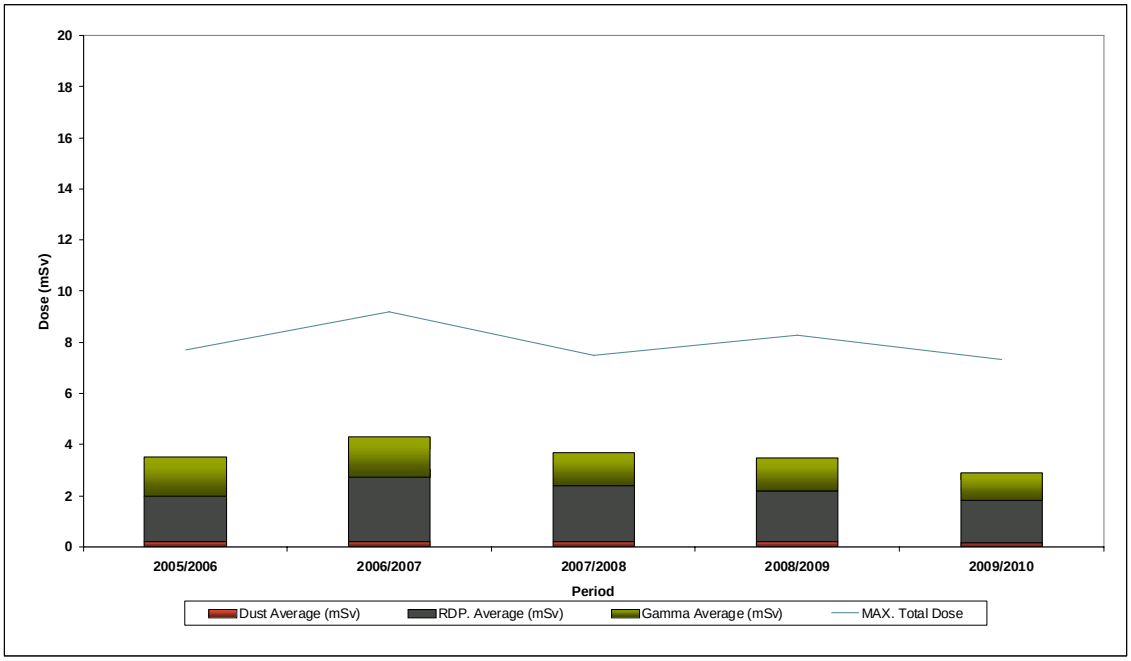


Figure 49 – Mine Annual dose trend

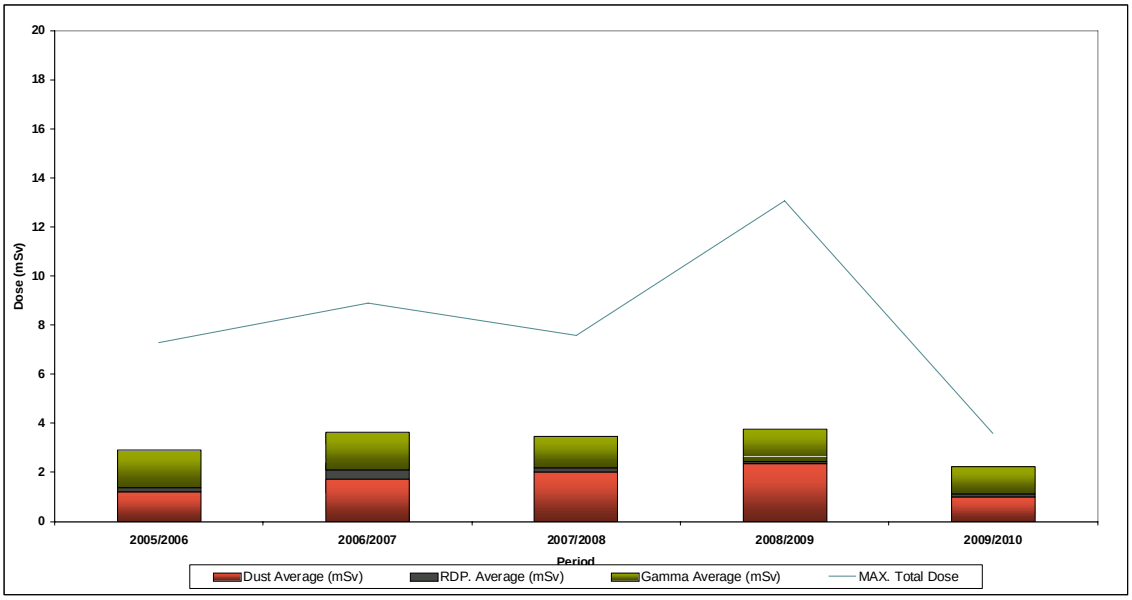


Figure 50 – Plant Annual Dose Trend

3.4 Doses to Members of the Public

The full assessment of doses to members of the public will be presented separately in the Environmental Management and Monitoring Report.

For all members of the public, the effective dose from the operation, for the period July 2009 to June 2010 was well below the statutory limit of 1 mSv per annum. Estimated maximum operational related doses are shown in Table J.

Table J – Public Doses

2009/2010 dose to Members of the Public living at	Dose (mSv)	Dose Limit (mSv)
Roxby Downs	0.008	1
Olympic Dam Village	0.009	1

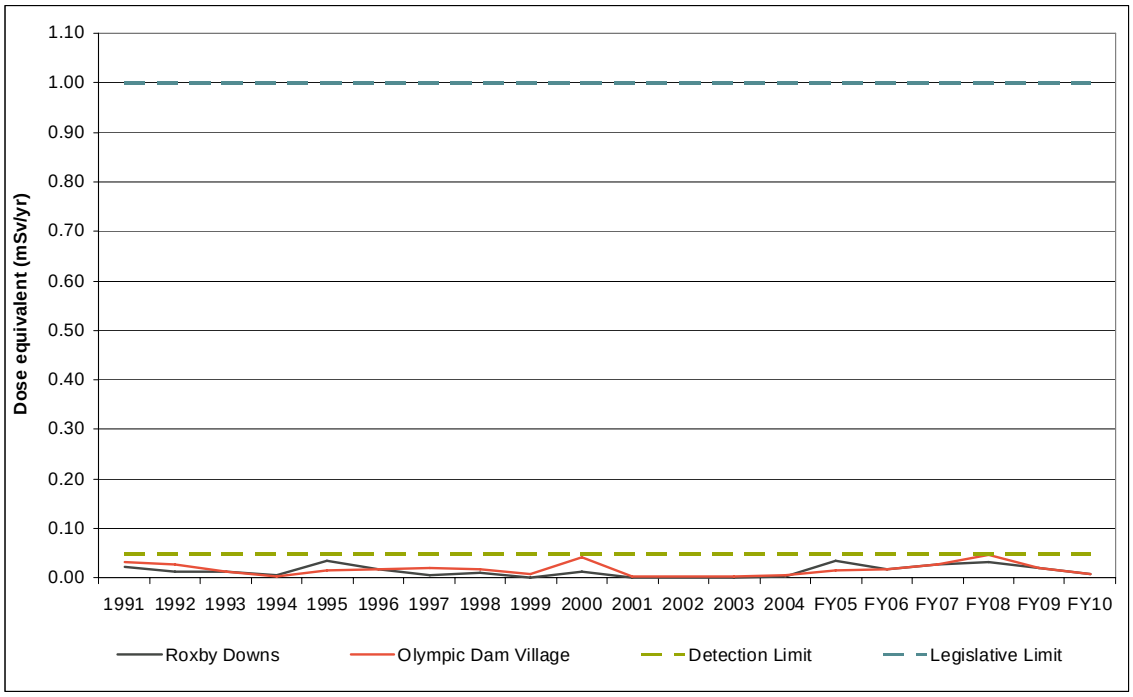


Figure 51 – Total Dose Trend for Olympic Dam Village and Roxby Downs

Shown in Figure 51 are the public dose trends for Olympic Dam Village and Roxby Downs since 1991. It is clear from the above graph that dose to the members of the public has not increased above the minimum detection limit of 0.048 mSv in all the monitoring periods.

3.5 Radiation Management Plan (RMP)

During the 2009/2010 reporting period a draft Radiation Management Plan has been submitted to the Environment Protection Agency (EPA) for comment. The process of approval of these documents will be the main focus in the 2010/2011 reporting period. Until such time the existing approved Radiation Management Plan is still in use and valid.

4 CONCLUSION

An extensive program of radiation monitoring and dose assessment is in place at Olympic Dam. The knowledge gained in the previous year during the dust recycle project at the Smelter has been applied to not only efficiently produce additional copper, but also reduce doses. The Clark shaft incident and resulting plant shutdown created abnormally low metallurgical plant doses. Doses for most areas are expected to return to normal historical levels in the following year at typical production rates

Assessment of employees' doses for the period 1st July 2009 to 30th June 2010 has shown that, out of a total of 945 designated employees, no employee received a dose greater than 37% of the annual dose limit of 20 mSv. The average dose to all designated employees was 2.5 mSv, with a maximum dose of 7.3 mSv.

The average dose to the 3060 non-designated employees was 0.8 mSv, with a maximum dose of 3.9 mSv.

APPENDIX A

Dose Conversion Factors 2009/2010

A summary of the airborne dust dose conversion factors for specific work areas can be viewed in the following table.

Table K - Dust Dose Conversion Factors

Location	DCF (µSv.m3/Bq.hr)
Smelter	7.5
Refinery / STP	5.4
SX / Precipitation / Calciners	4.5
Other*	4.1

*All other areas of Mine, Concentrator, Slag Concentrator, Hydromet and Services (Laboratories and Metallurgical Workshop)

The default RDP dose conversion factor used was 1.41 mSv.m3/mJ.hr (5 mSv/WLM).