IMPLEMENTATION OF THE RFA TEST BATTERY AT THE OCCUPATIONAL HEALTH CENTRE OF SISHEN MINE

by

NATALIE LOCHNER

Student Number: 24085724

A Project Submitted In Partial Fulfillment Of The Requirements For The Degree

BACHELORS OF INDUSTRIAL AND SYSTEMS ENGINEERING

In The Faculty Of

ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

UNIVERSITY OF PRETORIA

November 2009

SYNOPSIS

In order to act in accordance with Anglo American Health Way initiative to a commitment of Zero Harm, the identification, prevention and correction of mine workers' medical condition are provided for by the Rehabilitation and Functional Assessment (RFA) Test Battery capabilities. The RFA Test Battery was developed by joint capabilities of Anglo Gold Ashanti Health and Anglo Platinum. It aims to indicate the level of physical and functional capability a worker has to comply with the inherent job requirement of the mining environment*.

Obtaining a medical fitness certificate to work at Sishen mine is a Sishen Iron Ore Company requirement to ensure a productive and safe workforce. Labour Regulations, the Department of Mineral and Energy guidelines and Occupational Health and Safety Act instructs the indication of a clients' fitness to perform a specified work at a mine or the continuation of such a work. The RFA work assessment tool forms part of medical surveillance to determine overall work fitness during all phases of employment. Anglo Health Way has acknowledged the RFA Test Battery as a mandatory requirement for their mines as to practice Occupational Health and Safety standards, it was recommended by Anglo Medical Representative, Dr. Charlme Blignaut to implement the RFA Test Battery at Sishen Mine Occupational Heath Centre.

By objectively determining a workers' fitness level, the health risks related to their job specification are eliminated and a healthy worker can then add productive hours to Sishen operations. The RFA tests output have a tremendous impact on human resources strategy, directing the type of work a worker will be able to conduct and ensuring the correct placements of capable employees.

The study conducted at the Occupational Health Centre at Sishen Mine introduces the new test battery integrated with the current Medical Surveillance tests, by using Process Design. It necessitated capacity utilization calculations through Monte Carlo Simulation, estimating accurate cycle times for both the Medical Surveillance- and RFA tests. It was determined that 50 clients per day, which can be expected at the OHC, will be tested by the 12 available personnel, on the condition that clients conducting both Medsurv and RFA tests, to be completed within one day. It is obligatory to finish off all tests for each client, as required by Sishen Mine Management to prevent operator production hour's loss. By redesigning the current Occupational Health Centre facility layout, ample space can be provided to incorporate the test battery elements and ensure open channel communication and client transfer throughout the procedures.

The study concluded with a comprehensive Implementation Plan to direct, control and monitors the implementation of the RFA Test Battery. It suggests the use of phase implementation to prevent client congestion and under performing resource utilization. Although intangible aspects of the project such as Personnel Performance Appraisal framework and Change Management with regards to human resistance to change is not included in the document, systematic planning was invested and guidelines has been given to the Occupational Health Centre Supervisor to ensure sustainability of the Life Cycle commissioning and operational phases.

*** A detailed description of the RFA Test Battery is available for viewing in Annexure A**

Glossary

The definitions listed below apply to this document.

TERM	ACRONYM	DEFINITION
Sponsor		The Project Sponsor is an executive who provides commitment by management to define, defend and support the project from the start to the end.
Owner		The Project Owner is the person or Division which originates the project and to which the Asset is handed over to on completion.
Occupational Health Centre	OHC	The service provider of Medical Surveillance and Occupational Health related research.
Rehabilitation and Functional Assessment Test Battery	RFA	The physical assessment tool which must be implement at Sishen Occupational Health Centre.
Physical Work Capacity	PWC	The Physical Work Capacity forms part of the physical tests of the RFA Test Battery.
Functional Work Capacity	FWC	The Functional Work Capacity forms part of the functional tests of the RFA Test Battery.
Engineering Council of South Africa	ECSA	The Engineering Council of South Africa (ECSA) is a statutory body established in terms of the Engineering Profession Act.
National Union of Mineworkers	NUM	The NUM is the largest recognised collective bargaining agent representing workers in the Mining, Construction and Electrical Energy Industries in South Africa and the largest affiliate of COSATU, with offices in all the South African Provinces.
Anglo Gold Ashanti Health	AGAH	The Occupational Health department of Anglo Gold Ashanti.
Sishen Iron Ore Company	SOIC	The corporate body of Sishen Iron Ore Company as directed by Kumba Iron Ore Ltd.

TERM	ACRONYM	DEFINITION
Medical Surveillance	Medsurv	The anthropometric testing assessment required to be conducted by mine workers.
Occupational Medical Practitioner	OMP	The specialized occupational health medical doctor in service of SIOC.
Occupational Therapist	OT	The Occupational Therapist specializing in occupational health and wellbeing of mineworkers.
Physical Ability Assessment	PAA	The medical surveillance anthropometric tests conducted on mine workers in order to obtain access to the mining environment.
Voluntary Counselling and Testing	VCT	The voluntary testing and counselling for HIV Aids.

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

1 CHAPTER 1 INTRODUCTION

1.1 Background

The RFA aims to contribute to the wellbeing of workers by means of setting an industry standard to determine physical fitness to perform physical work in a safe, healthy and productive manner. The common physical assessment testing practised by Sishen was known as Physical Ability Assessment (PAA). It consists of subjective tests oblivious to inherent job requirements. After several injuries occurred during the testing procedure at Sishen Occupational Health Centre (OHC), it was considered a health risk for clients conducting the tests. In the years of development by Occupational Therapists of AGAH, the RFA Test Battery is now available to test mine workers' functional and physical abilities according to the inherent job requirements. Not only is the RFA Test Battery an indication of a workers' performance abilities, but it serves as a rehabilitation program providing the OMP information such as level of injury, functional recovering exercises and an assessment tool to determine whether the worker can be declared fit for work.

The current facility provides service to Medical Surveillance testing, Voluntary Counselling and Testing (VCT) of HIV Aids and a research hub for Occupational Health related risks and injuries in the mining environment. The Supervisor manages 12 staff members ranging from the Occupational Medical Practitioner (OMP), Occupational Health Practitioners (OMP), Occupational Health Assistants (OHA), Paramedics and administrative- and cleaner workers which form part of the Medical Surveillance testing department and research hub. An Induction Test is required to be completed before Medical Surveillance testing and form part of the access acquiring process.

The daily service provided by the staff ranges between 40-50 clients conducting different type of tests at the centre. Prospective and current mine workers require Medical Surveillance tests to be acknowledged safe for work for Sishen Mine, and are not allowed to enter the mine premises without the proof of medical fitness certificate.

1.2 Purpose Statement

For the RFA Test Battery to be introduced to Sishen Mine, several quantitative studies must be conducted before implementation of the Test Battery. It includes determining the required capacity of mine workers expected to undergo RFA testing at the OHC, establish physical- and human resource requirements, re-design the current facility layout and design the process integration of the current Medsurv tests with the new RFA Test Battery. The Change Management and Project Execution Approach are a SIOC requirement for the successful registration and approval of the documentation during each project phase but is not included in this document.

1.3 Scope of Work

Inclusions

The project output consists of:

-estimated client demand for Medsurv and RFA testing by using Monte Carlo Simulation

-facility layout alternatives with consideration to all aspects of the new test procedure and personnel space requirements

-architectural design of the facility

-strategic process design, integrating RFA and Medsurv testing, scheduling of resources and routing of clients

-managing the information system integration design and implementation

Exclusions

The project output excludes the following deliverables:

-recruitment of staff requirements as indicated by the productivity output of the project

-definition of inherent job requirements as input for the RFA Test Battery process design

-RFA Test Battery licence procurement and negotiations

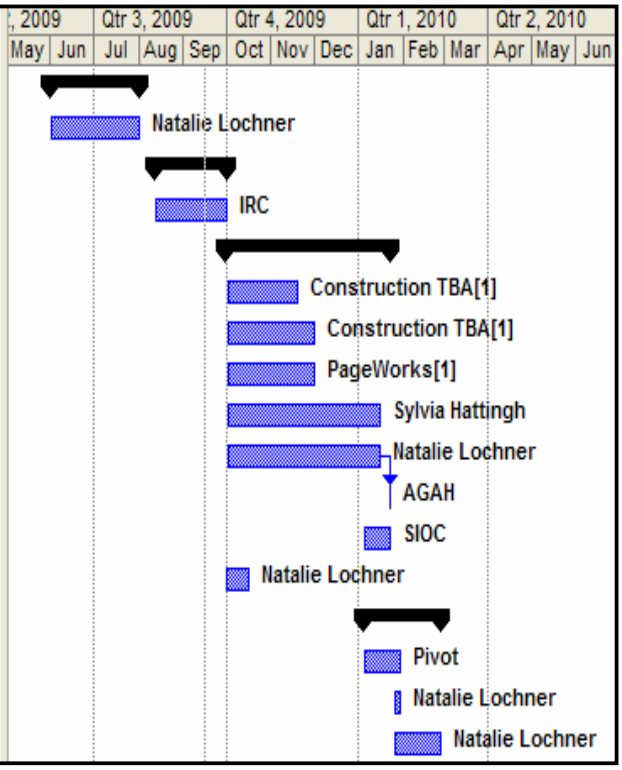
-documentation as required by the Project Assurance Committee of Kumba Iron Ore

1.4 Project Deliverables

The deliverable of the project is a final document describing the technical solution and execution plan for implementing the RFA Test Battery at Sishen Mine Occupational Health Centre. The document will be accompanied by an electronic version of the document, poster and simulation software application.

1.5 Project Schedule

Task Name	Start	Finish	Resource Names
Phase 1: EVALUATION	**Mon 6/1/09**	**Fri 7/31/09**	
Business Case study	Mon 6/1/09	Fri 7/31/09	Natalie Lochner
Phase 2: APPROVAL	**Wed 8/12/09**	**Wed 9/30/09**	
IRC Approval, funds releas	Wed 8/12/09	Wed 9/30/09	IRC
Phase 3: INSTALLATION	**Wed 9/30/09**	**Fri 1/22/10**	
Construction of Elements	Thu 10/1/09	Wed 11/18/09	Construction TBA[1]
Construction modification to	Thu 10/1/09	Mon 11/30/09	Construction TBA[1]
Design of visual communica	Thu 10/1/09	Mon 11/30/09	PageWorks[1]
OT recruitment and appointi	Thu 10/1/09	Fri 1/15/10	Sylvia Hattingh
Order of set-up equipment	Thu 10/1/09	Fri 1/15/10	Natalie Lochner
RFA Training of OHC Staff	Fri 1/22/10	Fri 1/22/10	AGAH
Installation of Cameras	Mon 1/4/10	Fri 1/22/10	SIOC
Pre-emptive Risk Assessme	Wed 9/30/09	Fri 10/16/09	Natalie Lochner
Phase 4: COMMISSIONING	**Mon 1/4/10**	**Fri 2/26/10**	
Information System Testing	Mon 1/4/10	Fri 1/29/10	Pivot
RFA elements testing	Mon 1/25/10	Fri 1/29/10	Natalie Lochner
Staff roll-out and RFA funct	Mon 1/25/10	Fri 2/26/10	Natalie Lochner



1.6 Document Structure

The document describes the literature research for the analytical studies and design content in Chapter 2. It elaborates on the use and applicability of the Industrial Engineering tools and techniques to the project.

Chapter 3 illustrate the practical outcome of the researched content. It describes the designed system environment, its resources and integration there-of. The alternative decision making process and operating methodology follow, depicting the operational change management in the system as a whole.

In order to execute the project literature, an Implementation Plan describes the procedures, standards and governance in a clear and concise manner. The report draws a conclusion on the lifecycle and project outputs, anticipating successful completion of the project deliverables.

2 CHAPTER 2 LITERATURE RESEARCH

Research was conducted on several Industrial Engineering tools which were applied during the evaluation, analysis and planning phases of the project. In order to provide a baseline process description, observation of processes must be done with associated time studies. It will provide operational parameters in designing the integration of the test battery testing procedures. Due to the uncertainty of quantitative parameters, it is recommended to simulate the results using Monte Carlo Simulation.

Using Arena to give a visual presentation of the proposed integration of processes, the output of the Monte Carlo Simulation is incorporated in the Arena simulation. After results have been generated it is now appropriate to modify the facility layout to accommodate the designed process. Alternative layout designs will be developed and based on set criteria the favourable design will be implemented.

2.1 Time- and Motion Studies

Although many an Industrial Engineer is reluctant to perform task orientated time studies, it is a powerful tool to analyse work procedures and determine benchmarking operations. The pioneers of time- and motion study, Frank and Lillian Gilbreth have done groundbreaking work in producing effective measurements for the efficiency of employees by balancing an economy of effort and a minimisation of stress, and psychological management in Lillian's interest. The research of Frank and Lillian Gilbreth are widely acknowledged as effective measures of work.

The process of doing efficient time studies is to observe the work environment, determine what must be measured by means of process mapping and conduct time studies by making use of a stopwatch.

2.2 Simulation

Monte Carlo Simulation

Monte Carlo Simulation was developed during World War ll to solve complex mathematical problems Waltz(1999:1). It became popular due to its ability to study unpredictable systems and reveal worst-case scenarios. The purpose of Monte Carlo Simulation is to introduce estimation of output numbers given uncertain input parameters. Simulation is use to understand fundamental concepts such as uncertain numbers an distributions as illustrated in SALVAGE (2003:20). Monte Carlo Simulation proposes large number of input numbers fed into the system and recording the range of outputs. David Hertz (1979) first introduced simulation as an analytical tool for business.

In simulating random input parameters, one has to build a model of the uncertain situation after which the simulation setting should be specify and then run the simulation and examine the results.

1. Building the model

A worksheet containing the relationship between the various numbers of the model must be developed modelled with the uncertainties created by a random generator which gives a random output number each time it is calculated.

2. Specifying the simulation settings

Formulating the relationship between the different input parameters, the output result in a range of high variability numbers.

3. Examine the results

Graphing the range of output numbers, a relative likelihood of each output number failing into the different ranges are displayed by the Histogram. The Cumulative Graph reveals the percentage of times the y-axis relates to the x-axis output numbers. Statistical analysis reveals decisional information such as averages, percentiles, standard deviation, maximum values and minimum values.

Simulation Modelling

Simulation modelling is a versatile tool due to its ability to deal with very complicated systems according to KELTON (2003:9). Systems are affected by random (stochastic) inputs and uncontrollable influences, effectively results in a random outputs. Discrete systems' changes occur at separate time instances. Simulation applied to the service industry in a more non-traditional way as a pre-solution step for integration of design and control problems. Analysing the environment help to understand and define the issues related to integration of design and control of the system.

It is a strategic tool which supports process improvements or development thereof. It addresses the use or objective of the simulation, the variables that can be usefully simulated and introduce alternative approaches that can be productively employed throughout the simulation. A model should be designed and developed for a specific applicability, to answer specific questions. Experimental conditions are equipped to define a model's intended applicability.

Simulating a scenario involves arrival of parts/clients, resource utilization, waiting lines and transport modes, all forming part of the various pieces of the simulation. Several performance measures are capable of indicating the progress of the system. The output data of average waiting time in queue, maximum waiting time in queue, average and maximum time in system and utilization can be collected at the end of the simulation. The results give an accurate replication of a real-life system and can be a clear indication to the amount of resources, number of stations and alternative process models.

Because of the wide affect simulation models have on its developers, the users and decision makers and individuals affected by the results of the model, model verification and validation is use to address the integrity and 'correctness' of the data. Sargent (2005:130) proposes that model credibility develops user confidence to use the model and the information derived from the model. The validity of a model may vary for different domains of the model. In obtaining a satisfactory valid model, several versions must be developed forming part of the total model development process. Sargent also explains that it is often too costly and time consuming to determine absolute model validity. (Sargent 1982, 1984) suggests a number of tests and evaluations to be conducted until sufficient confidence are obtained for the model to be declared valid for its intended use. Model Confidence illustrates the relationship between value, cost and model confidence. The increase of confidence directly increase cost but have a much more significant impact on value of the model to the user.

Several techniques are available in subjectively or objectively testing model validity. Such as animating of model, graphical displaying the model events as it moves through time, degenerated testing express the appropriate selection

of input and internal parameters and their values, comparing the real environment to those events of the simulation model, comparing extreme condition outputs, face validity requires involvement of the individuals knowledgeable about the system to reason the behaviour of the model, incorporation of historical data validation (time studies), internally validating by running several replications to determine stochastic variability in the model and sensitivity analysis of the input and internal parameter values.

The simulation environment enable a wide range of scenario's to be developed, illustrated, adapted and measured according to efficient time, cost or quality measure for best practice results.

2.3 Process Design

Process Design address the practical problem to find ways of cheaper, faster and more efficient industrial processes relenting to the art of designing alternative processes based on scientific principles. Changing the process involves the coordination of theory and challenges the dependencies between resources and tasks.

Process design can be based on four basic attributes according to Madison 2006.

- Frustration (as experienced by the user of the process)
- Quality
- Time
- Cost

Frustration amongst the people working within the processes has a correlation to quality of work. After finding out why the processes causes frustration, it must now be established what information the users are required to have to effectively do their job.

The most important Design Principles are:

- Work design must incorporate value adding activities, not functions or departments
- Centralised information flow to client, a single point of contact
- Provide consistent rate of service in limiting the number of people involved
- Design a process first before automating it
- Spread information bidirectional within process chains whilst capturing information once, avoid repetition
- Ensure continuous flow of value adding activities
- Have sufficient decision making roles at lower levels
- Use simulation, practical examples (dry-runs) to test new processes
- Involve the process-users in designing and implementation of process

The Process Design mechanisms suggest the illustration of alternative processes and direct the design criteria for changes to processes in the business environment.

2.4 Facility Layout Re-Design

In planning a facility layout, the tangible fixed assets involved in an activity must be determined how best it support achieving the activity's objectives. It requires a holistic approach, taking into account all elements of the environment. Integrating material/client and information flow in a top-down fashion, eliminating functional boundaries typical observed between facilitator and client, consolidating or merging of similar business entities, improving reliability of system by implementing robust systems, facilitate preventative maintenance with quality process design and decision making policies through innovative practices combining scattered information into a whole.

Facility design management models are widely used in assisting with managing the process from design to implementation. In designing the processes taking place in the proposed facility, in order to sequencing activities of procedures, a Precedence Diagram combines the Assembly Chart and Operation Process Chart, representing the flow of activities without any assumptions. When constructing a Precedence Diagram, it is recommended to start with the final activity to take place and work backwards until the first activity to take place. The flow of procedures must be simultaneous, symmetrical, natural, rhythmical and habitual.

To validate the best layout design, alternative layouts can be developed and based on a set criterion indicate the best option. Important considerations in determining requirements for the facility are flow, space and activity relationships (Thompkins 2003:79).

The layout arrangement, building configuration, equipment and strategies and lot sizes determined the flow of people or units. The space provide by the layout depends on all the flow elements mentioned as well as the offices, the restrooms and organizational policies. Activity relationships provides decision making considerations such as the organizational relationships provide by authoritative limits, the flow of people, material, information and money, and control relationships within the levels of integration and automation, the materials control and centralised versus decentralised control, and environmental relationships included as safety considerations, temperature, noise and dust control, and process relationships such as special services and requirements for water treatment.

3 CHAPTER 3 BUSINESS CASE

3.1 Technical Solution

The initial directive of the project is to determine the number of clients which the OHC must be able to test on a daily basis. It will dictate the size of the facility (scale of modification to the existing facility), the number of test elements to be implemented and the required additional staff members. A description of the daily procedures is illustrated to confirm the utilization of all resources.

3.1.1 *Capacity Study: Daily Demand*

The capacity studies are based on the demand from Sishen mine for medical tests. Investigation of the upcoming projects and the number of employees/contractors currently on Sishen resulted in a demand per day the OHC must accommodate. Historical data retrieved from Pivot indicated a service rate of 55 clients per day, taking into account the current employee number on Sishen Mine; the average estimated number of clients per day is shown in Table 1. Medical Surveillance testing is mandatory for all entries to Sishen mine, where RFA is mandatory for high risk occupations and medical compromised employees only. The total number expected for Medsurv is 47 clients per day of which 35 clients must do RFA testing.

Table 1 Daily expected client test rate

Weekends	Audit & SHE forums	Number of days in service per year							
104	24	195	FACTOR	Estimated number of employees per day according to Pivot	Number of medical case clients from Pivot	Number of high risk jobs on Sishen	Number of clients per day from Projects	Number of Sishen Low Risk Jobs	Average Estimation of number of clients
MEDSURV			Clients per DAY	55	16	6	13	12	47
			Clients per YEAR	10725	3160	1119	2511	2278	5001
RFA			Clients per DAY	55	16	6	13	0	35
			Clients per YEAR	10725	3160	1119	2511	0	4279

Monte Carlo Simulation was used to analyse the variability in the process. The Monte Carlo Simulation and its statistical output can be viewed in Annexure B.

The results indicated an average of 35 clients per day which must be tested by RFA tests. The 35 clients per day conducting RFA tests form part of an average of 51 clients per day for Medsurv. As the OHC is customer service orientated, it is calculated that 75% of the time the OHC will be able to accommodate 45 Medsurv clients per day and 37 RFA clients per day. Maximum RFA clients per day can be expected to be 41, and 60 Medsurv clients per day.

3.1.2 *Duration of Tests*

In order to facilitate the integration of Medsurv tests with RFA testing procedures, time studies were conducted on the current Medsurv procedures to indicate the utilization of human resources and duration of the tests, additional requirements and flow of procedures/clients. Time studies was conducted using a stopwatch and process flows after which the numerical data where simulated using Monte Carlo Simulation enabling an accurate estimation of the stochastic processes cycle time. The results of the average cycle time in minutes of the various Medsurv and RFA testing processes are indicated in Table 2. The Induction process which form part of the required periodic full tests and new employees/contractors, is not evaluated, but will be considered in planning of the daily schedule. Requirements for the RFA element testing are comprised of technical specifications, training and operational procedures which are explained within the RFA contract. All documentation regarding practices, procedures and requirements will be handed over as soon as the contract with AGAH is finalised.

Table 2 Time Study results of testing procedures in minutes

MEDSURV TESTS					RFA TESTS		COMBINED
X-ray	Blood-, urine tests, history taking	Vision	Lung	Audio	PWC	FWC	Physical Examination
6	7	8	4	11	60	50	13

The analytical studies indicated the duration of Medsurv testing of one client should not exceed 40 minutes. In the case were the client proceeds to RFA testing, the expected duration should not exceed 3 hours. It is however not the case currently as many complaints were received indicating a tedious waiting period between tests.

3.1.3 *Types of Tests*

Clients visiting the OHC undergo different type of tests. All new employees who did or did not work on a mine before do Baseline or Pre-employment. Baseline distinguished Pre-employment clients in that clients have never workerd at a mine before, were Pre-employment clients have some mining experience. The average cycle time for each type of test are indicated in Table 3 as well. Current employees must be tested periodically (Periodic Test), depended on the medical evaluation results completed on entry. A Periodic test is 6 monthly routine assessment of the clients' compromised health condition. A Periodic Full test requires a client to undergo a complete medical surveillance test on a 3 yearly routine. On termination of contract the client must undergo a complete medical surveillance test known as Exit Test.

Table 3 Type of Medical Surveillance tests

NAME	FREQUENCY	DESCRIPTION	NOTES	CYCLE TIME
Baseline Test	New employee or contractor who has never worked at a mine before	Audio Test Lung Test Vision Test X-ray Physical Examination Basic - BP, urine, Blood test dependent on glucose level of urine.		40
Pre-employment	Every new employee/contractor	Audio Test Lung Test Vision Test X-ray Physical Examination Basic - BP, urine, Blood test dependent on glucose level of urine.		40
Periodic Test	6 Monthly	Audio Test Lung Test	Noise & Dust level risk according to Hygiene Department estimations. For: Dust > 100 Noise > 85db	13
Periodic Full	3 Yearly	Audio Test Lung Test Vision Test X-ray Physical Examination Basic - BP, urine, Blood test dependent on glucose level of urine.		40
Exit	On termination of contract or employment	Audio Test Lung Test Vision Test X-ray Physical Examination Basic - BP, urine, Blood test dependent on glucose level of urine.		40
TB Patients	3 Monthly	Lung Test	Doctor examination	7

3.1.4 *Duration of Tests*

In order to satisfy the demand every day, the duration of each test are displayed in Table 4, indicating the amount of stations needed at each testing station. The operating philosophy used by the OHC team dictates the rotation of staff on a daily basis, thus each test will be facilitated by one staff member for the duration of the day, rotating daily. The calculations indicated that during the morning a minimum of 4.5 hours must be available to complete testing 50 clients. Because the different tests will end at different time stages of the morning, it is recommended to continue with the FWC tests as soon as they have tested all the clients at their specific station. Currently 4 OHA are employed of which 2 employees are Paramedics. It was indicated that another Paramedic will be appointed before the commissioning of the project. Vision testing requires two stations to accommodate the flow of clients. The 5 stations will be manned by the 5 assistants.

Table 4 Expected time frame for Medsurv testing

TEST	X-RAY	BLOOD-,URINE TESTS, HISTORY TAKING	VISION	LUNG	AUDIO	PHYSICAL EXAMINATION
Cycle Time per client (min)	5	5	7	4	9	11
Number of hours to test 50 clients	4	4.5	5.5	3	7.5	9
Number of stations	1	1	2	1	4	1
Number of hours according to nr of stations	4.0	4.5	2.8	3.1	1.9	8.8

Table 5 indicate the time necessary to test the clients with RFA. The Cycle Time for PWC includes 10 clients, the Cycle Time for FWC are calculated for each client. Each facilitator will be able to conduct tests on 2 clients simultaneously, 6 facilitators are available for testing. The Cycle Time includes the necessary time required for changing to testing clothing and time dedicated to administrative activities.

The assumption is made that 10 clients per PWC session will be accommodated and each facilitator will be able to handle 2 clients simultaneously conducting FWC tests.

Table 5 Expected time frame for RFA testing

TEST	PWC	FWC
Cycle Time per client (min)	60	50
Number of hours for 35 clients	3.5	3
Number of clients per session	10	12

3.1.5 *Daily Schedule*

The recommended schedule illustrated in Table 7 indicates the procedures for testing the required number of clients each day. On arrival, each client receives a card displaying the procedure of tests to be followed. Additional posters and indicators of the facility layout and process descriptions will be displayed against the wall within the OHC. It will ensure visibility throughout the centre, reduce confusion and improve cycle times. Bookings will be made according to balanced number of clients to arrive at different time periods. It is recommended to schedule the clients to arrive in batches of 12 each hour from 8:00 AM until 12:00 AM. From 7:00 AM to 8:00 AM follow-up clients will be tested. The PWC test starts as soon as the first 10 clients are available. After the client pass the PWC test, the PWC results will be communicated to him/her by the PWC facilitator. In the case of failure, the OT will consult with the client in private. The client may proceed to FWC if the results indicated a pass, after which the Physical Examination will follow by the OMP. A detailed schedule is available for viewing in Annexure C.

Table 6 Daily program for the OHC tests

TIME PERIOD	EVENT	RESOURCES REQUIRED
7:00 AM – 8:00AM	Personnel Arrive, Team meeting VCT and PWC testing starts Follow-up Clients arrive and conduct tests	All Personnel
8:00 AM - 10:00 AM	Baseline, Pre-employment, Period Full and Exit clients arrive and start with testing FWC testing starts	All Personnel OT facilitates FWC
MORNING TEA BREAK		
10:15 AM – 13:00 PM	Medsurv and PWC Tests completed FWC testing continues	All personnel
LUNCH		
13:30 PM – 16:00 PM	FWC testing continue, Physical Examination continue FWC testing and Physical Examinations completed	All personnel OMP

3.1.6 *Information System Flow*

Two information systems will be part of data transferring capabilities. The information transport between Pivot and RFA will be established to prevent double handling of client information. The RFA Test Battery is an independent web based server. Clients will be required to complete Medical Surveillance testing first, after which he/she move on to RFA testing, only those who are required to undergo RFA testing. Client identification information will be exported to the RFA web based application before starting with the tests.

An electronic measuring system will be in place, no data capturing activities of the test results will be necessary. The polar heart rate monitor information must however be manually downloaded to the RFA web based system. The RFA system will analyse the test information and produce a report which must be printed to Sishens' SharePoint server as well as printed for the OMP's perusal. Personal Computers will be installed within the testing facility to quicken the downloading and printing of results.

The weight and height are required to be determined by both Medsurv and RFA testing. It will however be measured only once during the Lung testing process which will be exported from Pivot to the RFA web based program.

3.1.7 *Process Description*

The integration of Medsurv and RFA tests require efficient scheduling for utilizing the personnel effectively. All Sishen employees are required to do VCT as part of the One Health Initiative by Anglo. VCT's are conducted from 7:00 AM-7:30 AM each day by the Calibre Contractors. Client arrivals from 7:00 AM to 8:00 AM will include 10 Follow-up Clients per day and 30 Sishen Employees per day. Follow-up test procedures entail one or more specific test(s) a client must undergo to monitor the progress of compromised or exposed health risks. All clients visiting the OHC for testing purposes, whether it is Medsurv or RFA, must complete the testing sequence with the last station at the OMP for Physical Examination.

All clients visiting the OHC must be scanned for TB by X-ray and History Taking before conducting the tests. Commissioning of the system will reveal the efficiency of the system. During the first stage of commissioning only medical compromised clients will undergo RFA testing. After balancing of resource usage, the number will increase to accommodate the workers doing high risk jobs on Sishen as well. Office workers are not obligated to conduct RFA tests. Pivot scheduling functionality will be program to balance the number of arrivals as indicated in Table 8. The throughput capacity of the designed system is 5 clients each 40 minutes.

Table 7 Balancing of client arrivals

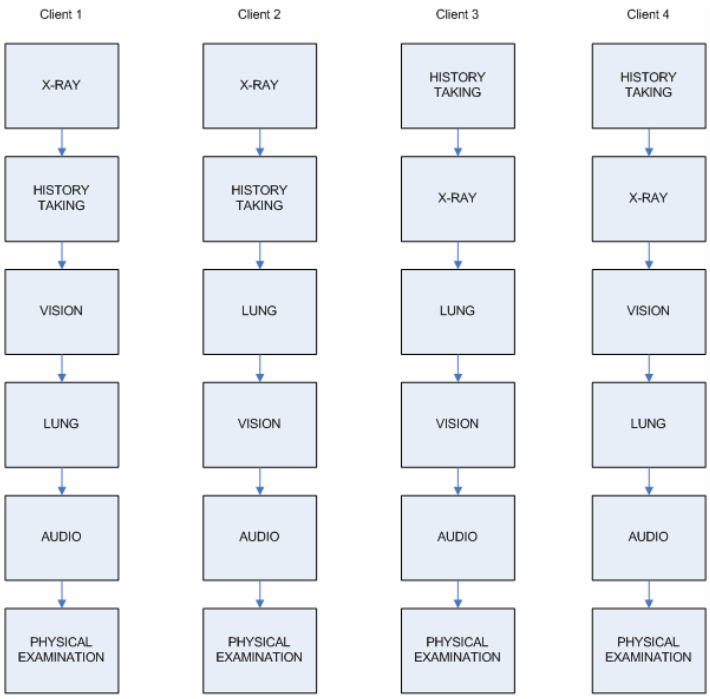
AM	SISHEN EMPLOYEES	FOLLOW-UPS	CONTRACTORS
7:00	10	10	
8:00	10		5
9:00	10		5
10:00			5
TOTAL CLIENTS/DAY: 55			

3.1.8 *Simulating the scenario*

Figure 1 indicates the process flow for clients doing only Medical Surveillance testing. The purpose of the simulation is to graphically display the integration of the testing procedures, to examine the average queue lengths, indicating the bottlenecks and confirm the resource requirements and usage. Throughout the model lifecycle, 10 replications were generated and animation of events was monitored. The values derived from time studies conducted on the current Medsurv testing processes as well as estimations of the RFA testing procedures according to operating facilities durations was use as input values for the model as well as the current number of Medsurv staff. Duration of the tests is represented as stochastic distributions. The Normal distribution with the average input as according to the time studies information was used. Dummy resources (OHA 1 – 4) are used for the RFA tests, representing Medsurv resources that finish their testing capacity and move on to RFA testing immediately. The resource is controlled by the failure functionality, indicating the operational time and the 'downtime' of the resource. The entities represent the client flow through the OHC. The process simulation model is appended in Annexure E.

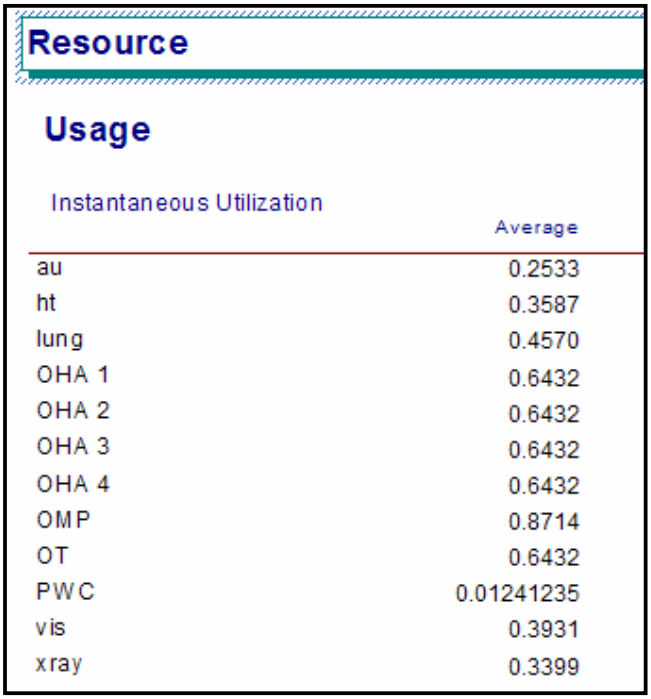
Simulating the client flow, the Time In System is average 2 hours. The simulation indicated a bottleneck at the FWC tests and the OMP consultation (Physical Examination). To eliminate the bottlenecks, the workload of the OHA's is balance to support the FWC tests as well. It is however recommended to engage the OHP who recently has been withdrawn, to support the OMP with Physical Examination. Not only due to the overload of clients must the OMP consult, but also the required administrative duties and meetings to be attended. If a client is required to do RFA testing, PWC and FWC must be conducted before Physical Examination and in the sequence. The inherent job requirements are determined to indicate what type of element tests the job required. The type and number of elements the client must be tested for related to his/her job description was developed by the Physiotherapist which relates to the average duration of the RFA Tests per client.

Figure 1 Testing process flow



In validating the model, the events, input and output parameters was discussed with the role players. Their satisfaction was apparent. The model is based on scientific input parameters and therefore resembles the scenario in the most credible position. Extreme conditions of number of clients increase was tested and indicated additional resources requirements. Test run changes were made to the number of resources dedicated to different stations. The Vision tests increased to 2 resources and the use of all OHA's and the Radiologist proof to be a productive output. Simulating the testing procedures for Periodic Full, Baseline and Pre-employment clients, the results are apparent that an additional OHA must be recruited to facilitate the FWC tests and consult the PWC test clients. The results indicated in Figure 2 shows sufficient resource utilization. The 'PWC' resource receives batches of 10 entities, resulting in the low utilization. It is calculated for every one entity seized, 10 entities was processed.

Figure 2 Resource Utilization



Resource

Usage

Instantaneous Utilization

	Average
au	0.2533
ht	0.3587
lung	0.4570
OHA 1	0.6432
OHA 2	0.6432
OHA 3	0.6432
OHA 4	0.6432
OMP	0.8714
OT	0.6432
PWC	0.01241235
vis	0.3931
xray	0.3399

3.1.9 *Resource Requirements*

After the results were concluded it is now apparent that additional staff must be considered. The OHC team totals to 16 staff members, including the supervisor. The breakdown of the team roles is illustrated in the matrix in Table 8. An additional Paramedic will be employed as a requirement outside this project. The capacity studies indicated the requirement for the services of an Occupational Therapist.

Table 8 Occupational Health Centre Organogram

OHC TEAM							
Authoritative	**Job description**	**Specialists**	**Job description**	**Routine**	**Job description**	**Admin and Support**	**Job description**
Sylvia	OHC Supervisor	Josephine	OHP Fit/unfit	George	OHA/ Paramedics Medsurv/RFA	Henriette	Receptionist
Doctor	Occupational Medical Practitioner	Vacant	OHP Fit/unfit	Alec	OHA/ Paramedics Medsurv/RFA	Yolanda	Receptionist
		Eunice	OHP Fit/unfit	Willem	OHA/ Paramedics Medsurv/RFA	Lena	General Attendant
		Althea	OHP Fit/unfit	Alfred	OHA/ Paramedics Medsurv/RFA	Charmaine	General Attendant
		Portia	OHP Fit/unfit	Vacant	OHA/ Paramedics Medsurv/RFA		
		Colleen	OT - Temporarily	Vacant	OHA/ Paramedics Medsurv/RFA		
		Serelda	Radiographer				

3.1.10 *Resource Utilization*

Resource utilization is estimated according to the cycle time per client. Utilization will varies according to the type of test a resource is dedicated to the specific day. The cycle time of tests and 1 hour dedicated to administrative duties are considered to be part of every staff members' job tasks. The time available for FWC testing, the number of FWC clients each facilitator will be able to handle and their respective utilization are indicated in Table 9. The OT start FWC testing from 7:00 AM each morning, by 12:00 AM the OT must have completed testing 9 clients. The facilitators continue FWC testing as soon as they have finish the client demand at their station. The Radiographer is not obligated to do RFA testing. An additional resource will be dedicated to PWC testing until after Lunch (Table 6), after which he/she must continue FWC testing. The PWC facilitator will be able to FWC test 4 clients a day, resulting in 100% utilization. The Occupational Therapist will have a large work load which will include facilitation of the results of

the PWC tests, FWC testing of rehabilitated clients as well as consultation with clients failing the tests. It is therefore critical to include an OT to the commissioning of the new RFA test battery. Breakdown of the number of clients to be tested by staff members are included in Annexure F.

Table 9 Staff Utilization

TEST	X-RAY	BLOOD-, URINE TEST, HISTORY TAKING	VISION	LUNG	AUDIO	PHYSICAL EXAMINATION
Number of hours according to nr of stations	5.0	5.5	3.1	3.3	2.2	10.5
Hours available for FWC testing	4	1.6	3.9	3.7	4.8	
Number of RFA FWC clients		1	4	4	5	
Utilization of resource	76.2%	90.5%	82.9%	84.9%	91.7%	130.0%

3.2 Option Analysis and Conclusion

3.2.1 *System Alternatives*

As Anglo Health Way requires the mining community to demonstrate their understanding of their responsibility to refuse to allow work to be undertaken or continued where harmful behaviour can result, the RFA Test Battery present the ideal opportunity to prevent harmful implications due to the mining environment on the mine worker and establish a rehabilitation plan for injured workers.

The RFA Test Battery has already been implemented and successfully operated by 7 Anglo Gold Mines. Although there is one related mining physical assessment system currently available in the market, the RFA Test Battery enjoys preference due to its objectivity and accurate results.

To ensure the health and safety of the worker, it is important that the worker's functional work capacity equals the physical demands of their work tasks and work environment. The Functional Work Capacity (FWC) test battery focuses on all types of physical work tasks and work environments in the mining industry, ensuring an accurate match and its usefulness and reliability is appreciated by mine management. It contributes to the overall health, morale and prosperity of the mining community, to ensure a productive workforce.

The RFA Assessment tool is also successfully use to evaluate injured or medically affected mine workers for alternative placement and ensures new employees are placed in a job matching their physical capacity. In the case of current employees as well as new employees failing the test, the necessary implicational conduct of practice must be established. It will entail an agreement between SIOC Human Resources and NUM.

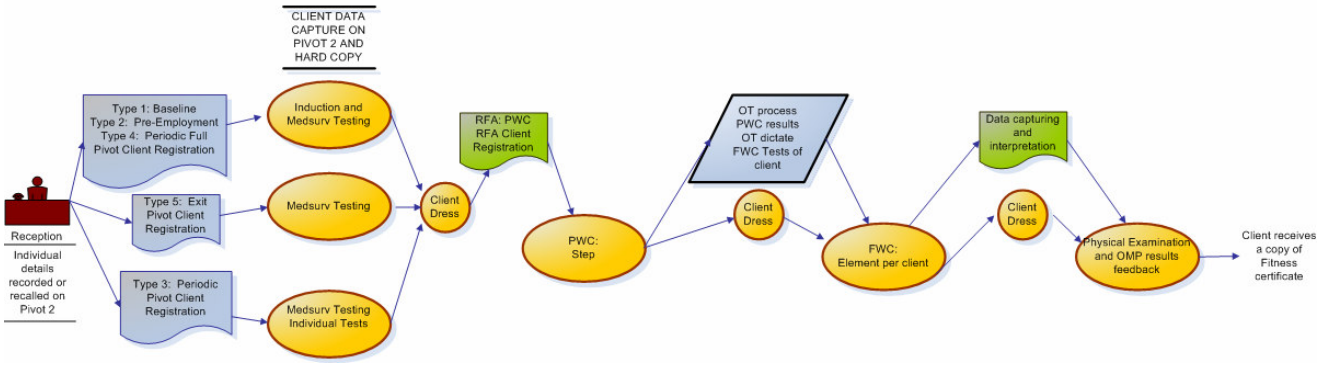
3.2.2 *Location*

As the existing facility provide housing for the Medsurv tests, the facility offer the best option for implementing the proposed RFA tests, enabling clients to complete all required tests in a centralized facility. It will reduce travelling time for clients, eliminate high costs in setting up a new facility and improve communication channels for administrative purposes.

3.2.3 *Facility Modifications*

Alternatives for modification of the existing facility are developed and selected based on a generic criterion. The most applicable option is chosen and quotation for construction expenses is requested. Alternatives for the modification to the facility's layout was considered and criterion-based rated. The implementation of the RFA system requires ample space for client and staff movement, with an additional office for the proposed Occupational Therapist. After establishing process flow of the tests, a Precedence Diagram indicates the flow of sequence in Figure 2.

Figure 3 Precedence Diagram of tests



The criterion consists of layout characteristics, flow, space, activity relationships, information system capability; client load implied and cost benefit and is use to judge the relative importance of each criterion as compared to each other.

Alternative 1 is designed the FWC in both sides of the corridor and PWC outside in a moveable container. Alternative 2 is also designed for the FWC to be both sides of the corridor and the PWC outside in a build apartment. Alternative 3 is designed for the FWC and the PWC in the facility and the staff tea room move outside, to a modified single room. The layout designs can be viewed in Annexure G.

It is necessary for the changes to the current staff offices orientation. It is indicated that the OHP offices will be relocated to the mine vicinity. Thus 4 offices become available which will be use for the OHA relocation. The current facility provides different office space which will be used for testing rooms. The Audio Test takes place within a soundproof room and dictates to ensure the noisy FWC tests to be located as far possible and soundproof from the Audio Test room. The Lung- and Vision tests and History Taking procedure will take place in the large area known as the Medsurv hall. Part of the hall forms the OHA's office space which provides 4 cubicles for administrative and personal activities.

Table 10 demonstrate the criteria based rating of the 3 alternatives. The highest total score indicates the most optimum layout and will be implemented. The chosen layout for the project is alternative 3.

Table 10 Layout Design Criteria

	LAYOUT CHARACTERISTICS				FLOW			SPACE	ACTIVITY RELATIONSHIPS					INFORMATION SYSTEM CAPABILITY		CLIENT LOAD IMPLIED			COST	
Factors	Total distance traveled	Floor visibility	Overall aesthetics of the layout sentiment and taste	Ease of adding future business	Sequential process flow (maximize directed flow paths)	Flow of information (redundancy, effective points of info)	Flow of operators	Space utilization	Client/staff movement	Organizational relationship: influenced by span of control and reporting relationships	Centralized or decentralized processes	Levels of automation and integration	Environment relationships: safety, temperature, noise, fumes, humidity, dust, security	Space and people requirements	Network availability	Human factor risk	Impact on space capacity	Impact on system requirements	Cost	Total
Alternative 1	0	0	0	1	1	0	0	1	1	1	0	1	1	0	0	0	1	0	0	8
Alternative 2	0	0	0	1	1	0	0	1	1	1	0	1	0	0	0	0	1	0	0	7
Alternative 3	1	1	1	1	0	1	1	0	0	0	1	0	0	1	1	1	0	1	1	12

3.2.4 *Supplier requisition*

The list of suppliers specified for the set-up components as included within the RFA Test Battery Agreement will be used as some of the equipment is not Off-the-Shelve equipment. In the case of basic clothing and generic equipment, current SIOC suppliers will be considered.

A FWC automatic monitoring system will be procured directly from the supplier. It is a new system, one of a kind and has been uniquely developed for the RFA elements.

3.3 Operating Solution/Methodology

Clients will be scheduled according to the scheduling methodology programmed on Pivot 3. It will be according to the smooth balancing of human resources utilization. On arrival clients will receive client cards indicating the procedures to follow throughout the centre. As each clients type of tests may vary, customized cards will be use. Medical case clients and follow-up clients will be tested first after which all clients arrived will be tested. If the client is required to conduct the RFA tests, according to the client card received, the client must continue to the RFA change rooms and follow the procedures. It is required from the RFA candidate to change to comfortable clothes and PPE when conducting the exercise, clothing will be provided.

After tests have been completed, the client receives feedback indicating whether the client has failed or passed and may continue with the FWC tests. In the case of failing the PWC test, the OT counsels the client and recommends a RFA related health and fitness improvement program. Recommendations regarding internal relocation of employees will be delegated to the Human Resources Department.

If the client passes the PWC test, he/she may continue to the FWC test elements. Several elements are available to test the client, specific elements will be chosen dependent the type of the clients' work. It is necessary to change to PPE clothing for the duration of the FWC testing. After the tests have been completed, feedback from the OT or facilitator provides insight as to the outcome of the tests. The client may now proceed to the physical examination by the OMP who will interpret the RFA results and provide a final diagnosis, indicating whether the client is or is not fit for the job specification. The client receives a certificate of fitness approving their physical fitness condition for the inherent job requirement or receives a follow-up appointment date for retesting.

4 CHAPTER 4 IMPLEMENTATION PLAN

The purpose of the chapter is to identify the requirements for implementing the project based on the design criteria in Chapter 3. It outlines the risks associated with the project to manage and control the hazards and it describes the factors to consider when introducing change to the operating environment. Quality checks and peer reviews are use to control the project output based on the standard governing the project. The execution plan is set out as steps with the associated resources and procurement plan.

4.1 Asset Risk Management

Table 11 Risks Identification

DESCRIPTION	CAUSE	IMPACT	MITIGATION	RISK OWNER
Finalisation of the RFA contract between KIO and AGAH	No conclusion on contract content	Cancellation of project	Re-investigate business case	Sylvia Hattingh
Schedule sustainability		Project de-scoped	Re-design of schedule	Natalie Lochner
Construction delays	External causes	Extended operational readiness	Adjust schedule	Natalie Lochner
Additional Occupational Therapist not approved		Non-compliance to operating philosophy	Re-strategise operating philosophy	Sylvia Hattingh
Availability of project funds	Project not include in yearly budget	Construction extended to 2010	n/a	Nicholas Howard
Late delivery of RFA set-up equipment	Supplier delay/lengthy lead time	Late project commissioning	Order equipment on time	Natalie Lochner
Additional system components not approved	Components are an extra cost, not necessary for the project	Change process methodology	Re-design process modelling	Nicholas Howard
Information System not ready	Upgrading of Pivot has individual project schedule	Booking and scheduling of clients inefficient	Align RFA project schedule with Pivot upgrade schedule	Natalie Lochner/Marius Williamson

4.2 Considerations: Change Management

The following changes will have an impact on the current procedures. The causes of the impact are discussed in Chapter 2: Operational Readiness.

Table 12 Change Management activities

OPERATIONAL READINESS	CHANGE MANAGEMENT ACTIONS
Construction modifications must be complete	Changes to the facility layout will bring process changes, relocation of certain offices, relocation of the tea room. Relocation of the OHP offices to the mine must take place. SIOC safety procedures must be adhered to during construction. Certain test equipment will be move to another location within the building while construction takes place.
RFA testing elements must be implemented and tested. Calibration of equipment according to the Calibration Register of Sishen Mine	The RFA elements must be constructed and implemented at the centre. The implementation of the RFA elements will fill the dedicated area.
The Medsurv testing area must be modified and equipment must be placed	The vision, lung and history taking tests will be conducted in one location. The audio and x-ray testing will remain at their current location. Separate area for the OHA's offices will be available next to the Medsurv room.
Data share between Information systems must be tested and operational	Communication and development with Qmuzik to obtain data share between the information systems. Scheduling and rebooking of clients must be activated within the information system. Implementation and testing must take place before roll-out.
Personnel must be trained for operating the RFA system	Personnel must undergo RFA training at AGAH, Carletonville. Integration procedures and operational interfaces of the Medsurv and RFA testing must be explained to the personnel.
The services of an OT must be available	Recruitment of OT commences.
Visual Communication must be implemented within the centre.	Design, printing and implementation of the visual communication must take place.

4.3 Assurance Interventions

4.3.1 *Peer reviews*

A peer review will be held prior to the presentation of the project to the IRC. The members of the peer review will include:

Jacques Maré – Capital Project Coordinator

Louise Marx – Sishen Continues Improvement Facilitator, Industrial Engineer

Pieter Olivier – Industrial Engineering Mentor

A staff review meeting held 17 September 2009 was facilitated by the PM. The process design and methodologies as well as client flow in the OHC were discussed with the relevant OHC staff members including the OHC Supervisor. The outcome of the meeting intended the approval of the relevant parties. The outcome was achieved.

4.3.2 *Project Assurance Committee (PAC) and Gate Release*

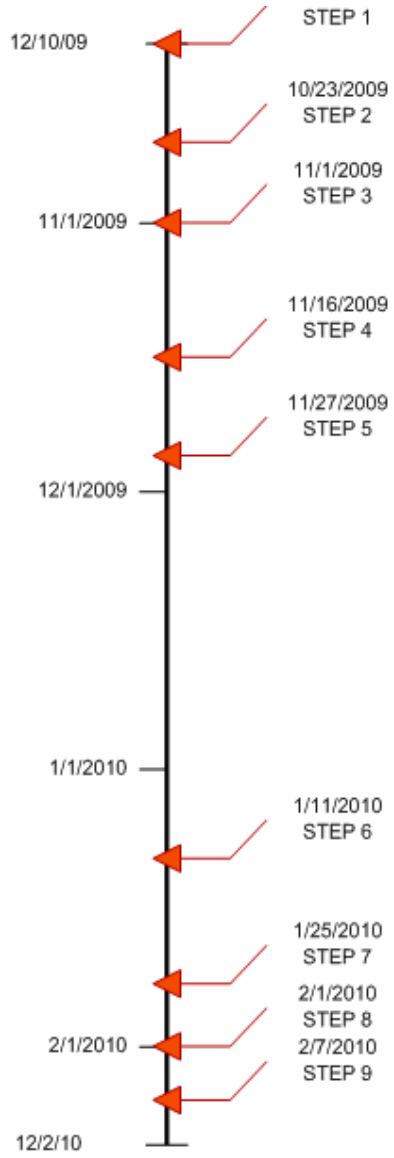
Table 13 Gate Release Schedule

GATE REALEASE	WHO	WHEN
Charter Approval	PAC	25 August 2009
Study Report Approval	PAC	TBA
Presentation of project	IRC/SLT	TBA

4.4 Execution Plan

The following steps will be followed when the project funds have been released. The steps in Figure 2 relates to the steps described.

Figure 4 Execution Plan time line



STEP 1	OHP office will be evacuated; Occupational Hygiene personnel will be relocated to the OHP'S offices. Construction contractor will be informed, construction will begin
STEP 2	Ordering of all set-up components will take place.
STEP 3	Visual Communication drafts will be confirmed. SIOC approval process will be followed. Hand over of posters will take place. Implementation of posters will be executed after construction is completed
STEP 4	Construction of RFA elements will commence
STEP 5	Recruitment of additional staff initialized
STEP 6	Training of personnel for RFA testing will be booked and executed
STEP 7	Interface definition of the information systems completed, interface developed, tested and implemented
STEP 8	Project hand-over to client
STEP 9	Stage commissioning of operations

4.5 Implementation Resources

Resources necessary for the successful implementation of the RFA Test Battery are indicated:

Operational: Procurement of licence includes the requirements set out for the set-up components: equipment, signs, clothes, stepping blocks, FWC automatic monitoring system of the RFA elements, corporate communication signs and integration of the information systems.

Engineering Design: The design of process flow, integration of tests and design of facility modification necessitates engineering specifications. It is conducted by the Industrial Engineer, following recommendation by the RFA Test Battery owners.

Construction: An external construction contractor will be use to apply the construction modifications to the facility and assemble the RFA test elements. After consultation with the approved construction contractor of SIOC, it was indicated that the demand for the construction exceeds their capacity. An alternative construction company were consulted and a quotation was incurred.

Financial: The expenses incurred by the lifecycle of the project are discussed in Chapter 3.1

Human: Construction contractors and set-up suppliers

4.6 Procurement Plan

The Procurement Plan indicates the products to be procured, the recommended supplier, the date by which it should be ordered and the expected date of delivery in Table 14. In recognition to the long lead times of certain products, an acceptable lead time period is included. The content of the required set-up components are described by the RFA license agreement. The list of suppliers is made available by the RFA developers and used accordingly.

4.7 Quality Checklist

- Quality checks should be conducted on arrival of equipment, ensuring customer satisfaction, safety and quality of equipment.
- A certification of pre-tests conducted on the automatic monitoring system and metronome should be presented on delivery of system.
- Testing of system will take place during the commissioning phase as well. Manufacturing guarantee must be included for the thermometers, heart rate monitors, electronic scale and hygrometers as a standard certification of compliance.
- Inspection of the construction site must be conducted daily.

4.8 Standards

- The construction contractors must adhere to the National Building Regulations throughout the construction phase.
- Standard PPE as required by SIOC must be used for testing clothing.
- The standard procedures for testing, data capturing and consultation according to the RFA manual must be used.

5 CONCLUSION AND RECOMMENDATION

When integration of processes takes place, Change Management guidelines are applicable to ensure collaboration and alignment of work methods. The study is based on the demand Sishen Mine has, to test the current and future workers. By evaluating the known estimations with Monte Carlo Simulation, an accurate prediction is made directing the facility layout redesign, resource- and process requirements. The deliverables conform to Industrial Engineering principles based on productive work output.

Not only does the tangible asset of the project require initiative and effective design, but also the intangible factors such as employee satisfaction, selling the changes the project brings to Sishen Internal Review Committee and Sponsors, implementing the changes and management of project life cycle.

6 REFERENCES

Case Study: Applying Process Design Principles. 28 November 2006, Daniel J. Madison: http://www.bpminstitute.org/articles/article/article/case-study-applying-process-design-principles/news-browse/15.html. Access date: 6 October 2009

Crowston, K. 1997. A Coordination Theory Approach to Organizational Process Design, *Organization Science,* Vol. 8, No. 2, Pages 157 – 175

Groenendaal, H., Zagmutt, F. 2006. Spin of the Wheel: The Role and Reality of Monte Carlo Simulations, *Risk Management,* 53: Page 10

Gentle, J.E. 1943. *Random Number Generation and Monte Carlo Methods*, 2nd edition. Springer

Hertz, D.B. 1979. Risk Analysis in Capital Investment, *Harvard Business Review,* 57

Kelton, W.D., Sadowski, R.P., Sturrock, D.T. 2003. *Simulation with Arena*, 3rd edition. McGraw-Hill.

Savage, S.L. 2003. *Decision Making with Insight,* 1st edition. Thomson Brooks/Cole

Sargent, R.G. 2005. Verification and validation of Simulation Models, *Proceedings of the Winter Simulation Conference*, 4-7 December 2005: Pages 130-143

Thompkins, J.A., White, J.A., Bozer, Y.A., Tanchoco, J.M.A. 2003. *Facilities Planning, 3rd edition.* John Wiley & Sons, Inc

Waltz, D.K. 1999. Use of Monte Carlo simulation techniques can improve underwriting and loan monitoring, *The Secured Lender*

ANNEXURE A: RFA TEST BATTERY SCOPE OF WORK

Rehabilitation and Functional Assessment

Scope of work

Sishen Iron Ore

Contents

1. Introduction: The Rehabilitation and Functional Assessment (RFA) Test Battery

The Rehabilitation and Functional Assessment (RFA) Test Battery was designed to assess physical and functional work fitness to perform manual work safely without adverse health consequences. The product is currently licensed to 7 mining houses in South Africa.

2. The RFA Joint Venture‘s mission and vision

The RFA Joint Venture (JV) is an initiative between AngloGold Ashanti Health (AGAH) and Anglo Platinum (AP) to develop and maintain an objective, valid, reliable, and reproducible work assessment tool to determine and manage physical fitness over a full work shift. This work assessment tool forms part of medical surveillance to determine overall work fitness during all phases of employment.

It aims to contribute to the wellbeing of workers by means of setting an industry standard to determine physical fitness to perform physical work in a safe, healthy and productive manner.

3. Membership

The Test Battery is licensed to other mining companies’ by means of two contractual agreements: A License Agreement and a Confidentiality Agreement. Drafts of the Agreements will be forwarded to the company representative by the AngloGold Ashanti Commercial Services Department.

Licensing the product to other mining companies enlarges the database; refinement of test standards, research, sharing of knowledge and experience on the Occupational Health front between various companies is beneficial.

Annual license fees include:

- Consultation on the setting up and establishment of the RFA Centre
- Access the to RFA Software
- Help desk services for any RFA related queries including IT related problems
- Training of the occupational therapist and RFA operators in the theory and administration of RFA assessments
- Two operational audits annually to ensure reliable and valid test outcomes and to establish a high level of service
- RFA Manuals

4. Application of Work Capacity Assessments within an Occupational Health setting

Application of the RFA Test Battery	Purpose of the assessment
Pre-employment assessment *(preventative approach to fitness to work)*	The effective placement of the worker: Matching the worker's functional work capacity with the job demands.
Risk based medical surveillance *(pro-active approach to fitness to work)*	The early identification and the management of health and safety risks affecting overall fitness to work.
Periodical medical surveillance *(preventative approach in order to maintain fitness to work)*	Identification and management of risks associated with physical fitness to work. Promotion of a healthy lifestyle as the test outcome indicates the impact of possible risk factors on work capacity.
Monitoring of rehabilitation *(re-active approach to fitness to work)*	Monitoring effectiveness of rehabilitation to ensure early and safe return to work. To ensure effective redeployment of the worker.

5. Proposed Test Elements

To assess employees' work capacity, the following test elements would be recommended for use at the Sishen Iron Ore RFA Centre:

- Physical Work Capacity Test
- Functional Work Capacity Test:
  - i) Maximum lifting
  - ii) Frequent lifting
  - iii) Stair climbing
  - iv) Climbing over obstacles
  - v) Ladder climbing
  - vi) Lashing
  - vii) Dexterity (table top, above head, standing on a ladder, supine, kneeling)

Test element	Description	Purpose
Physical Work Capacity	10 minute step-up test.	Determine cardio respiratory fitness to perform physical/dynamic type of work.
Maximum Lifting	6 different types of loads to be lifted at 2 different levels.	Determine occasional load handling capacity.
Frequent load handling capacity	Handling a load on 3 different levels against a physiological work load that predicts performance over a full work shift.	To assess manual material handling for more than 34% of the work shift.
Stair climbing	A set of stairs at a 45 degree incline against a physiological work load that predicts performance over a full work shift.	To assess stair climbing ability and capacity over a full work shift (metallurgical plants).
Climbing over obstacles	Climbing over 3 sets of obstacles at different heights. The surface traversed is uneven.	To evaluate agility, dynamic balance and weight bearing on the lower limbs.
Ladder climbing	A vertical ladder.	Non standardised test for the assessment of climbing ability (metallurgical plants, climbing into extra heavy duty vehicles).
Lashing (Restricted and unrestricted)	Lashing in an upright / stooping position.	To evaluate upper limb strength and endurance.
Dexterity elements	Different dexterity elements: • Table top • Stooping • Kneeling • Supine	To assess the ability to perform tasks requiring good use of the hands (handling of spanners, nuts and bolts), accommodating different work positions.

Test elements may be constructed by engineering / maintenance departments within the company from scrap metal and material. Detailed plans for the design and construction of test element are provided in the form of a manual.

6. Equipment and Estimated Costs

Estimated setting up budget
(Excludes buildings, air conditioning and test elements)

RFA Centre			
Guidelines: Basic Setting Up Budget (All prices are excluding of VAT)			
General equipment	**Unit Price**	**Quantity**	**Total**
Platform scale (SI 122)	R 3,900.00	1	R 3,900.00
Polar watches (RS400) (price incl VAT)	R 3,395.00	10	R 33,950.00
Polar handle (price incl VAT)	R 895.00	2	R 1,790.00
Interface (price incl VAT)	R 595.00	2	R 1,190.00
Measuring tape	R 400.00	1	R 400.00
Whirling hygrometers	R 250.00	1	R 250.00
Thermometers	R 20.00	100	R 2,000.00
Stopwatches	R 150.00	3	R 450.00
Metronome	R 8,000.00	1	R 8,000.00
Television	R 4,000.00	1	R 4,000.00
DVD player	R 500.00	1	R 500.00
	Sub total		**R 56,430.00**
Signs	**Unit Price**	**Quantity**	**Total**
Safety signs	R 7.00	35	R 245.00
Emergency assembly point sign	R 220.00	1	R 220.00
Test element signs (100 mm x 330 mm)	R 25.00	7	R 175.00
Test element signs (50 mm x 330 mm)	R 15.00	7	R 105.00
Name sign boards + installation costs			R 2,000.00
	Subtotal		**R 2,745.00**
Test Clothing	**Unit Price**	**Quantity**	**Total**
Shorts: Small/Meduim/Large	R 44.95	80	R 3,596.00
Shorts : XL/XXL	R 46.95	80	R 3,756.00
Ladies tops Small/Meduim/Large	R 54.95	30	R 1,648.50
Ladies tops: XL/XXL	R 57.95	30	R 1,738.50
	Sub total		**R 10,739.00**
PWC stepping blocks	**Unit Price**	**Quantity**	**Total**
1 cm	R 100.00	15	R 1,500.00
1.5 cm	R 100.00	15	R 1,500.00
2.5 cm	R 150.00	15	R 2,250.00
4 cm	R 200.00	15	R 3,000.00
5 cm	R 250.00	15	R 3,750.00
6.5 cm	R 250.00	15	R 3,750.00
9 cm	R 280.00	15	R 4,200.00
	Sub total		**R 19,950.00**

R 89,864.00

ADDITIONAL PPE NEEDED FROM SAFETY STORES	**Quantity**
Hardhats	80
Gloves	80 pairs
Socks	80 pairs
Overalls (different sizes)	80 (in total)

Possible Additional Costs

Office furniture	
Desks	2
Bookshelves	1
Computer operator chairs	2
Armchairs	2
White board	1
Notice board	1
Metal waste bins	6
Metal keyholder box	1
2 tier metal lockers	20
10 litre containers	2
Benches	5
Computer equipment	
Computers	2
Print server	1
Laser printer	1
Network points & cables	1

7. Facilities

A proposal with regards to the possible layout of the Sishen Iron Ore RFA Centre is attached (refer to Appendix 1) based on space that is possibly available within the current Occupational Health Centre. An assessment of possible limitations in terms of the capacity to accommodate 40 clients per day, and future expansion of the Centre is included.

8. Human Resources (staffing)

The following staff compliment would be recommended for the assessment of an average of 40 clients per day:

- Physiotherapist (currently available on site 2 days per week)
- 4 assistants of which 1 should be a paramedic (multi skilling of assistants is recommended in terms of data capturing and administration of assessments)

For logistical and change management reasons it is recommended that assessments are phased in. Phased implementation will furthermore ensure a gradual build up in numbers of clients and thus provide time for staff members to gain skills in terms of test administration.

A 1 week training course for both the therapist and the assistants is compulsory and will be presented at the AngloGold Ashanti RFA Centre. As indicated in the License Agreement, no training costs are involved other than the cost of traveling, accommodation and meals.

Once training has been performed, all medical cases must be assessed by the physiotherapist / a qualified therapist. Assessments of non-medical cases may be performed by the assistants. Reports for such cases may be generated electronically by means of the web based RFA Software. The possibility exists that the paramedic may also be trained to capture reports of non-medical assessments only.

Rehabilitation programs must be planned and updated by the therapist and may be executed by the sport scientists at the gym in conjunction with the assistants at the RFA Centre. A combination of conditioning in the gym and vocational rehabilitation in the RFA Centre is recommended. The size of the facility and the number of clients assessed per day may influence the capacity of the Centre to accommodate larger numbers of rehabilitation cases.

9. Implementation

Further consultation will be provided in terms of the implementation of the RFA Test Battery and establishment of the RFA Centre. The possibility of involving an Industrial Engineer in the planning of the layout and size of the RFA Centre as well as the number of staff to be allocated exists and would be recommended in conjunction with the recommendations as made in this document.

Sishen Iron Ore will be responsible for the involvement of all relevant role players, change management and documentation of processes surrounding the implementation and management of assessments and the outcomes thereof.

Different processes are proposed for the assessment of:

- Prospective employees
- In-service employees as part of risk based / periodical medical surveillance
- In-service employees post illness or injury

The following processes (refer to Appendix 2) serve as examples of the application and management of RFA assessments as part of medical surveillance. A basic guideline on the actual process flow within the RFA Centre is also included (Appendix 1).

Processes need to be discussed and altered to suit the processes within and the needs of the company. Documentation and revision of the referral process and management of outcomes is furthermore of importance in order to ensure efficient processes.

Phasing in of the assessments should be considered. Once again, planning surrounding the process, documentation thereof and communication to all relevant role players is of utmost importance.

Refer to Appendix 3 for guidelines on the process of establishing a RFA Centre.

10. Benefits

- The design and methodology of the assessment tool aimed at addressing overexertion and incomplete recovery after physical tasks.

- Establishing an objective criteria and standards for physical fitness to ensure adequate placement of workers according to their physical abilities.

- The structure of the assessment tool allows functional work capacity assessments through all phases of employment

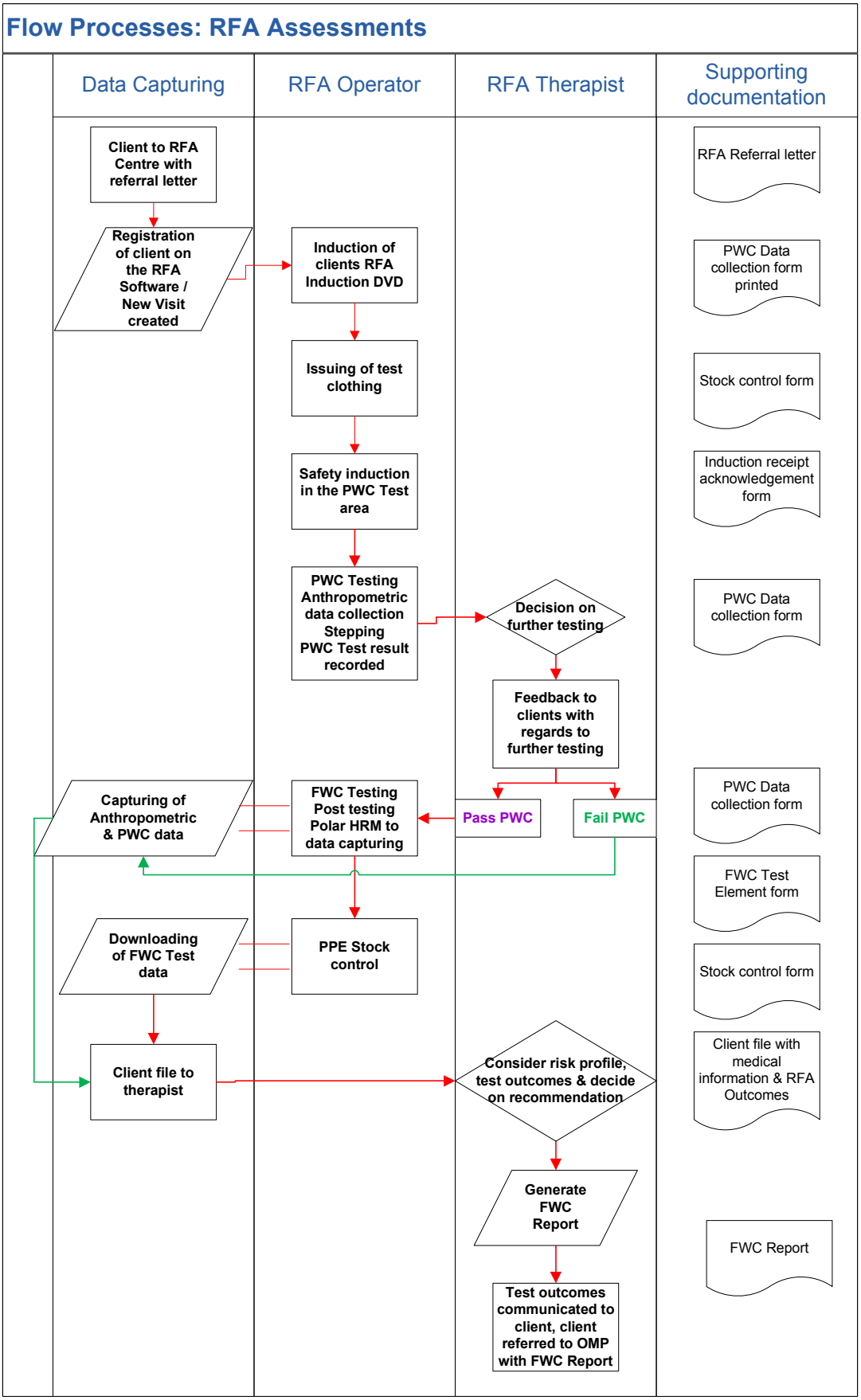
- Job profiles developed as part of the test battery allow for a more informed job allocation or re-allocation process. The job intensity rating system identifies occupations with high physical demands.

- In the case of injured or ill workers the assessment tool provides standards of fitness to resume work, or in cases where workers will not resume with their current duties, provides alternative employment.

Contact details:

Tia-Mari Hofmann	RFA Co-ordinator	082 576 9911 thofmann@anglogoldashanti.com
Daleen Schoombee	RFA Occupational Therapist	084 800 0212 dschoombee@anglogoldashanti.com

Appendix 1: Possible layout of the RFA Centre


Flow Processes: RFA Assessments
Data Capturing
RFA Operator
RFA Therapist
Supporting documentation
Client to RFA Centre with referral letter
Registration of client on the RFA Software / New Visit created
Induction of clients RFA Induction DVD
Issuing of test clothing
Safety induction in the PWC Test area
PWC Testing Anthropometric data collection Stepping PWC Test result recorded
Decision on further testing
Feedback to clients with regards to further testing
Pass PWC
Fail PWC
Capturing of Anthropometric & PWC data
FWC Testing Post testing Polar HRM to data capturing
Downloading of FWC Test data
PPE Stock control
Client file to therapist
Consider risk profile, test outcomes & decide on recommendation
Generate FWC Report
Test outcomes communicated to client, client referred to OMP with FWC Report
RFA Referral letter
PWC Data collection form printed
Stock control form
Induction receipt acknowledgement form
PWC Data collection form
PWC Data collection form
FWC Test Element form
Stock control form
Client file with medical information & RFA Outcomes
FWC Report

Flow of clients through the RFA Centre and subsequent requirements:

Proposal for the assessment of 40 clients per day

Process	**Area**	**Considerations / possible limitations** (***with reference to the proposed layout)***	**Requirements**
Client registration	Reception area (Area 1)	Privacy: clients' background and medical information is captured (file and interview used as sources). Reception area: space is limited. Due to the limited number of clients that can be accommodated in the proposed reception area, the flow of clients from the Occupational Health waiting area to the RFA reception area may limit time efficiency. Filing of client information will have to be done in another area due to space limitations. Induction will possibly have to take place in another area, again due to space limitations.	• 1 or 2 network points with computer and printer • Plugs • Computer workstation for data capturer • Benches/chairs for clients • Filing cabinets (a different filing system may be considered given the space restrictions) • A TV and DVD player should be available in the waiting / reception area for viewing of the RFA induction DVD. Due to space restrictions, this may possibly have to be placed in the PWC Test area.

Process	Area	Considerations / possible limitations (*with reference to the proposed layout)*	Requirements
Issuing of test clothing, clients to change for PWC testing	Change rooms	Change rooms must be designed to accommodate approximately 20-30 males and 10 females at one point in time. As clients will be wearing shorts (male clients) and shorts and shirts (female clients), this area must be private and enclosed and there should be a direct entrance into the PWC Test area. Separate facilities for males / females are recommended. Other than the lockers required in the change rooms, storage space is also required for the storage of test clothing.	Female change rooms may be smaller than male change rooms. OH statistics may be used to determine the average number of females assessed per day. • Floor covering: tiles • Toilets and basins (usage of and access to ablution facilities in the Occupational Health waiting area can be considered when determining the actual number of toilets, urinals and basins required). • 1-2 showers (optional) • 15-20 double lockers (to allow for safekeeping of 30-40 persons' belongings at a time) to be placed in the male change rooms. • 5-7 double lockers (to allow for safekeeping of 10-14 persons' belongings at a time) to be placed in the female change rooms. • Extractor fan • Lockers for storage of test clothing to be issued to clients to be placed in the change rooms or in the passage between the change rooms and the PWC Test area.
Physical Work Capacity (PWC) Testing	PWC Test area	The stepping block must be positioned in the middle of the room. Space must be left on all sides of the stepping block for the movement of clients and test administrators.	• Floor covering: non-slip, hygienic, easy-to-clean tiles. • Benches for 16-20 clients should be positioned against the walls. • Table or medicine trolley to place heart rate monitors, disinfectants etc. on.

Process	Area	Considerations / possible limitations (*with reference to the proposed layout)*	Requirements
Physical Work Capacity (PWC) Testing	PWC Test area	Racks may be mounted against the wall for the storage of PWC stepping blocks. Standard racks may also be used, mounted racks however requires less space.	• A temperature of between 21 and 25ºC must be maintained in the PWC area. Air conditioning is thus essential. • In order to ensure good air quality, the insertion of three extractor fans is also recommended. • A sunken footbath is required in order to ensure good hygiene. A drain is required in the footbath as well as water supply (hot and cold water). The footbath could be positioned in the passage area or in the PWC Test area, pending actual space available. The footbath should preferably not be positioned directly across the entrance so as to allow for a walkway into the PWC Test area without entering the footbath. • Installation of a network point is recommended: capturing of PWC data may be done in the PWC Test area. • Plug for the electronic scale (positioning to be planned accordingly). • Depending on the space available, lockers for the storage of test clothing may be stored in the PWC Test area. Care should however be taken not to limit comfortable movement.

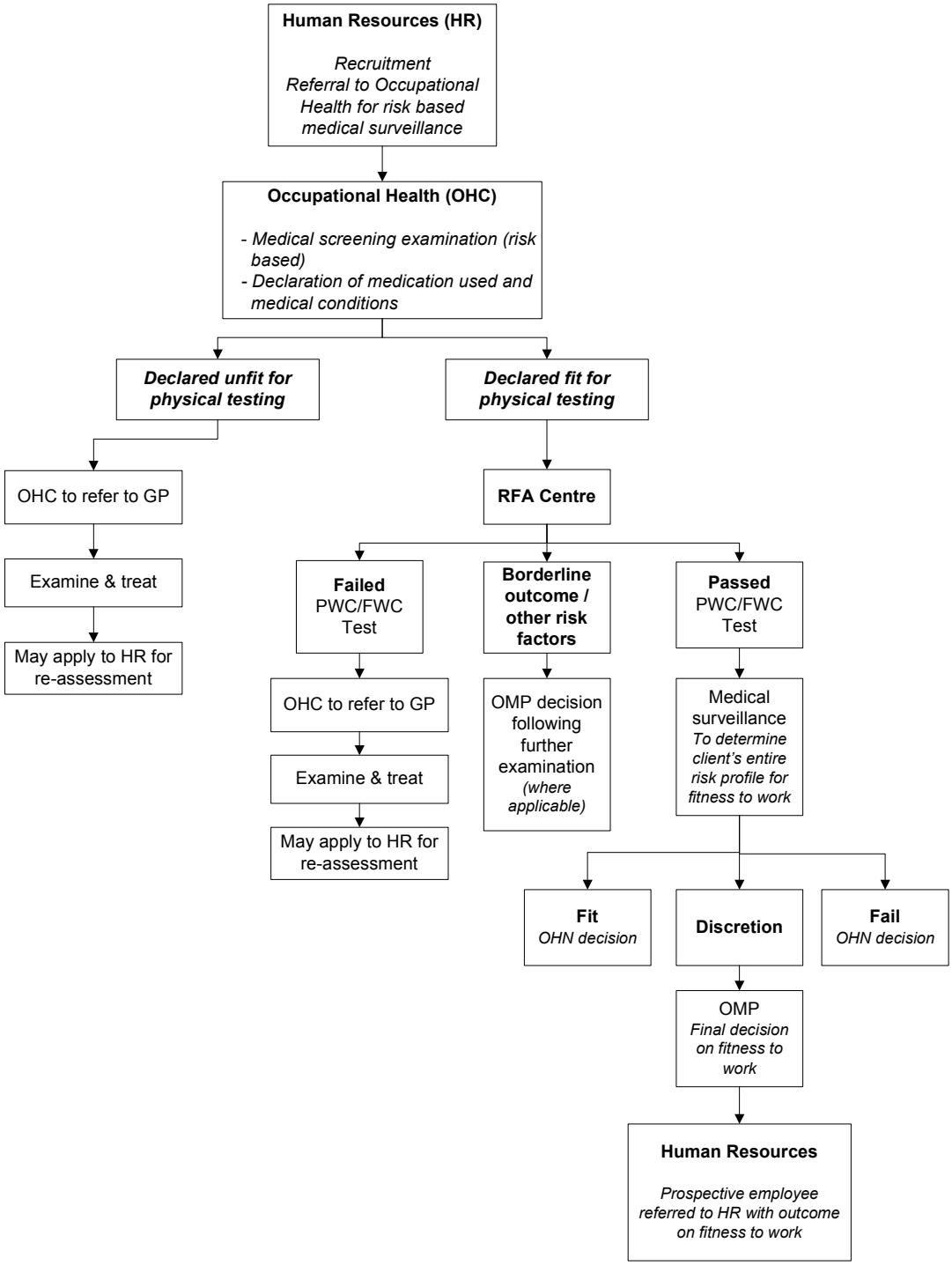
Process	**Area**	**Considerations / possible limitations** (***with reference to the proposed layout)***	**Requirements**
Issuing of test clothing, clients to change for FWC testing	Change room	Refer to the considerations as mentioned above.	Refer to the requirements as mentioned above.
Functional Work Capacity (FWC) Testing	FWC Test area	Provision has been made for 2 sets of lifting shelves in order to allow for more efficient flow / assessment of 40 clients per day. Only an unrestricted Lashing test element was accommodated; due to space limitations following the addition of the Climbing over obstacles test element, there is no space available for a restricted Lashing test element. Space limitations impacts on the possibility of adding additional test elements if required e.g. Impact activity or Handling loads in restricted work areas.	• Floor covering: cement. • A temperature of 21-25ºC must be maintained in the FWC Test area. In order to ensure good air quality, the insertion of extractor fans is also recommended. • The ceiling height above the stair climbing test element must be 3m. • Plug may be provided for the installation of a water cooler (positioning to be planned accordingly).

Process	Area	Considerations / possible limitations (*with reference to the proposed layout)*	Requirements
Clients to change post testing	Change rooms	Refer to the considerations as mentioned above.	Refer to the requirements as mentioned above.
Data capturing	Reception area	Refer to the considerations as mentioned above.	Refer to the requirements as mentioned above.
Feedback to client	Therapist's office	No space was available for the allocation of an office to a therapist. Privacy is required in order for the therapist to discuss the confidential test outcomes with clients. Should another office be used in the vicinity of the RFA Centre, the logistics in terms of the time spent for clients to move between the Centre and the office. Assessment of clients (muscle strength, range of motion etc.) and interviewing of clients prior	• A network point, computer, printer and plugs.

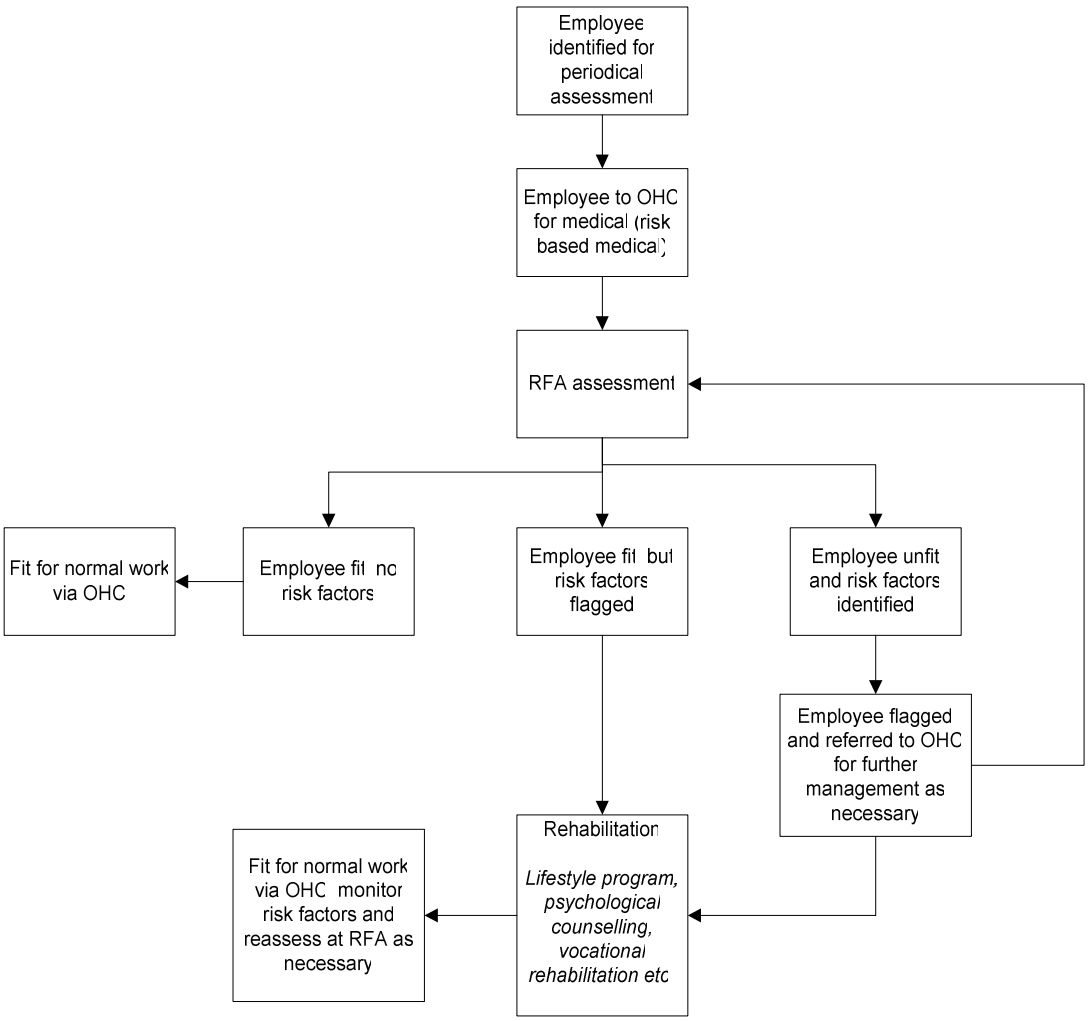
Process	Area	Considerations / possible limitations (*with reference to the proposed layout)*	Requirements
		to testing should also be performed in the therapist's office.	

Appendix 2: Examples of RFA Assessments as part of medical surveillance

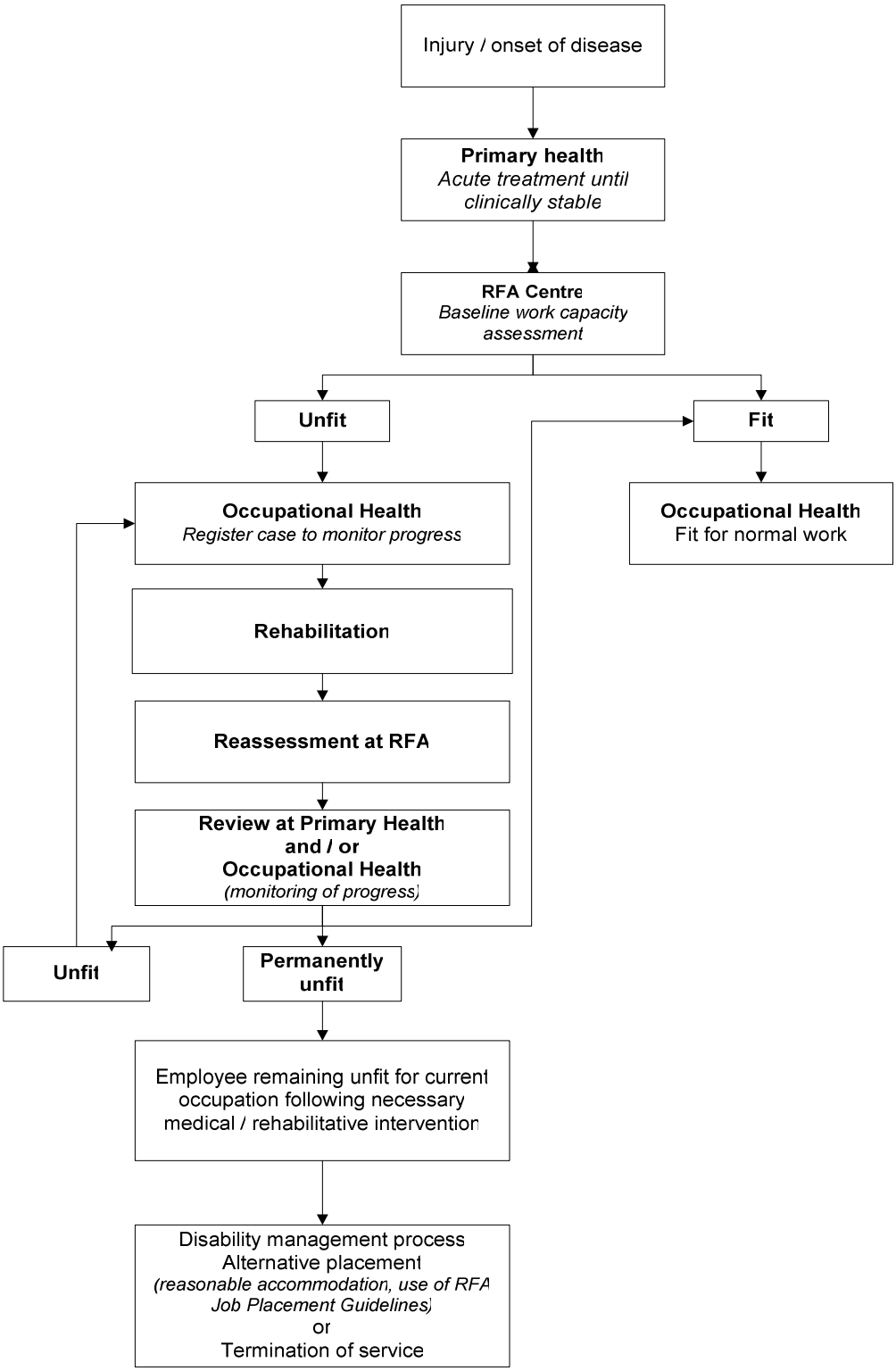
Prospective employee assessment



Periodical Assessments

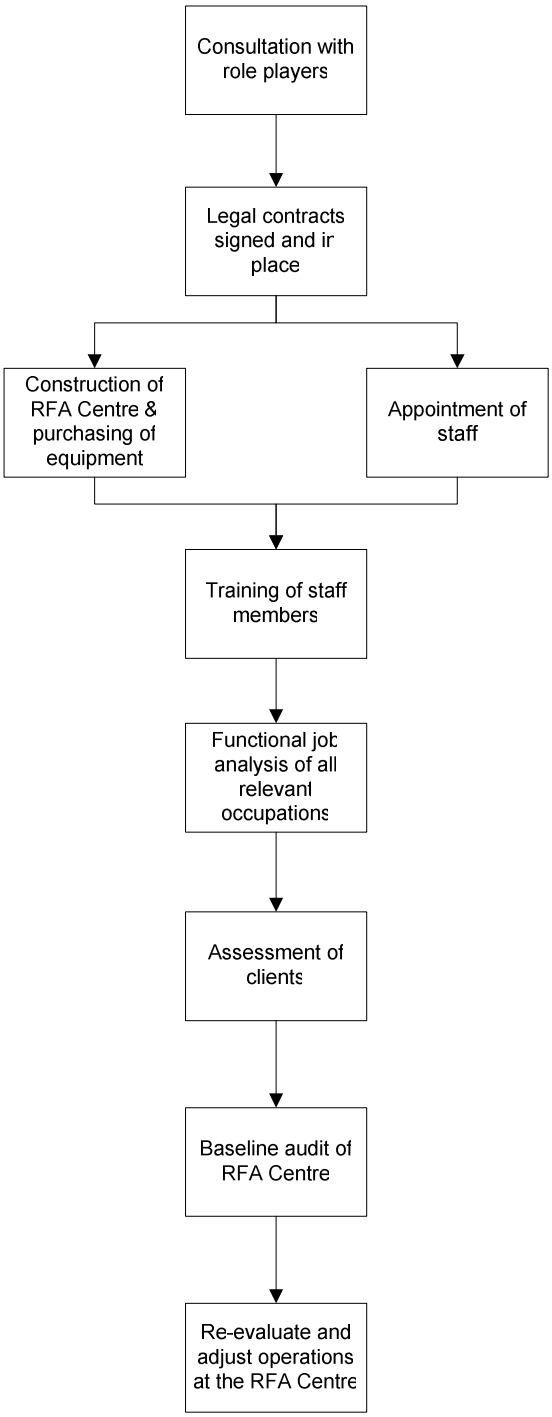


RFA as part of rehabilitation



Appendix 3: Guidelines for the setting up of a RFA Centre

Guidelines for the setting up of a RFA Centre



ANNEXURE B: MONTE CARLO SIMULATION OUTPUT DATA

STEP 1 BUILDING THE MODEL

Input Data			Factor	0.2	
Variable		AVE	MIN	MAX	STOCHASTIC
X1 =	Estimated number of employees per day according to Pivot	55	44	66	53
X2 =	Number of medical case clients from Pivot	16	13	19	14
X3 =	Number of high risk jobs on Sishen	6	5	7	6
X4 =	Number of Sishen Low Risk Jobs	12	9	14	10
X5 =	Number of clients per day from Projects	13	10	15	10
Variable	MEDSURV PROCESSES				
M1 =	X-RAY	7	2	10	5
M2 =	BLOOD,URINE, HISTORY	5	3	10	6
M3 =	VISION	8	5	10	6
M4 =	LUNG	3	3	5	3
M5 =	AUDIO	10	6	15	13
M6 =	PWC	50	50	70	61
M7 =	FWC	40	30	70	42
M8 =	PHYSICAL EXAM	10	5	20	5

STEP 2: SPECIFYING THE SETTINGS

Processes	X-RAY	BLOOD,URINE, HISTORY	VISION	LUNG	AUDIO	PWC	FWC	PHYSICAL EXAM
Average	**4.92**	**5.50**	**6.60**	**3.68**	**9.03**	**56.50**	**43.61**	**10.56**
Variable	M1	M2	M3	M4	M5	M6	M7	M8
	8.912128	5.16090806	7.249325	4.584835	4.342169	69.17157	40.32318	13.94780204
	1.840033	5.541396771	5.875671	4.338714	10.67527	69.57415	47.945	10.57917732
	1.755744	9.196562812	8.996772	3.235674	10.53571	62.2767	38.10859	19.93349396
	8.670299	7.187613483	8.375	3.764537	2.712664	65.62798	69.16039	11.07983416
	1.091158	9.989439856	8.753899	3.603165	7.337898	59.59011	24.01566	19.7489087
	3.862242	2.228132135	6.384019	3.910153	2.197985	54.10361	59.27194	11.01492191
	0.250567	1.614940262	5.699721	2.427174	13.63101	59.06297	47.3195	1.877646312
	6.92063	1.08901312	9.31977	3.179673	7.668461	53.34707	42.72261	18.03625457
	2.871757	7.16487428	7.895722	3.460406	3.935686	50.73283	40.33271	6.099266091
	2.399757	8.755226816	6.477696	4.11266	10.79517	63.37739	33.78567	5.468058913
	4.007595	0.400837954	6.449041	3.777081	14.10411	59.69877	57.82869	7.445310395
	8.965555	2.32906848	6.335253	2.895911	8.765983	62.82721	47.44527	12.49475893
	6.835109	6.414343515	4.264764	4.760705	6.610418	58.16071	36.48565	17.5881074
	5.408697	4.085234791	9.106458	3.680855	7.205258	67.12018	53.03271	10.01667944
	9.321661	5.800966922	7.949973	4.791856	12.67597	51.66834	44.26819	9.900346914
	5.213246	4.158633034	5.792549	3.420428	10.93196	63.16425	46.3608	6.925662726
	0.977183	5.513073678	8.019868	3.071929	14.08974	66.56562	39.45361	3.480480479
	5.280423	6.104482246	4.33018	4.644489	11.9291	62.23382	68.1652	13.2151462
	3.716832	5.90243046	7.549822	4.018811	3.881867	61.42414	35.49804	18.40441519
	1.054554	3.869444694	4.352716	4.664779	13.70131	52.37073	37.17044	1.326506621
	4.036988	8.501078837	8.721747	3.110029	6.258755	50.85706	37.17649	14.90688214
	6.055834	5.216893318	6.065152	3.27143	6.147087	61.63664	36.83546	7.399514445
	7.215078	9.428588265	9.046225	3.979328	13.7522	50.72375	34.10636	6.604839866
	6.398199	1.651957019	5.248682	3.330129	12.52892	51.5975	16.89702	13.42312855
	2.881425	3.071293829	6.17438	4.14744	14.00831	56.57315	46.56189	13.16917785
	0.735353	2.317951712	3.971221	3.965883	11.80766	54.16946	66.29142	1.273506858
	8.19425	4.773055581	7.568535	3.407827	13.19188	46.81529	19.20291	16.254841
	0.782808	2.608840901	8.204767	4.107872	12.98307	58.30304	45.34287	12.76647946
	1.198001	3.218345663	6.787596	3.99624	11.47611	54.49054	51.48278	4.082108286
	1.422036	4.304960182	8.901147	3.499392	5.454286	57.61571	36.19386	13.58957511
	2.005836	6.728383417	6.576561	4.254534	9.291337	62.2182	60.83701	0.014757386
	7.707499	8.333741788	9.908445	4.173815	5.072928	63.70764	38.85424	5.543400977
	2.777013	4.973546255	5.884752	3.597675	10.01781	69.86548	39.83039	13.54863685
	6.684972	6.296603969	9.591661	3.589995	0.558382	66.75156	56.68613	13.49981019
	3.141321	8.238919215	4.331382	3.277683	9.452684	47.80386	63.59805	18.79991424
	5.672491	3.136235558	5.034613	4.024042	6.756072	54.21088	29.02714	4.28613541
	4.114027	1.168367289	5.362907	4.385079	9.461542	58.13502	43.9211	5.071287028
	8.246545	1.630254048	5.002278	3.94792	9.802545	66.45461	37.82815	15.31657956
	1.08761	7.109930153	8.225448	3.560074	2.255835	55.87853	51.6651	7.64069124
	1.692205	3.2944032	3.140758	2.922943	12.35127	50.26089	51.30648	16.33203515
	0.898893	6.741356474	5.677896	3.724537	5.530524	63.88018	32.8583	14.33679585
	5.492633	8.17682957	9.593506	3.686779	8.233018	58.65244	33.4352	11.47070586
	6.859177	7.863857702	5.444795	4.4408	7.870582	63.93196	49.55445	5.810325552
	7.227133	7.21740011	7.24083	4.739901	7.711573	63.39267	35.21559	19.26219713
	2.330683	5.706846966	7.334441	4.05018	10.06647	55.11574	60.07033	1.559818854
	5.401693	5.431020205	5.244421	4.189758	8.361637	66.27274	69.46917	9.418456115
	8.538155	3.429722128	3.865924	4.53368	13.98029	55.78255	13.99789	5.055084665
	8.678847	7.588609111	5.58928	3.344709	2.820766	43.98283	57.77662	16.39458314
	5.884741	3.400649732	9.294719	3.743336	10.096	68.03238	48.01243	15.84601048

STEP 2: SPECIFYING THE SETTINGS

	MEDSURV						RFA			
	Estimated number of employees per day according to Pivot	Number of medical case clients from Pivot	Number of high risk jobs on Sishen	Number of Sishen Low Risk Jobs	Number of clients per day from Projects		Number of medical case clients from Pivot	Number of high risk jobs on Sishen	Number of clients per day from Projects	
DATA POINTS	X1	X2	X3	X4	X5	AVERAGE/ DAY	X2	X3	X5	AVERAGE/ DAY
Data Point 1	65.34455057	13.27643774	4.279506143	13.52533201	10.08581676	53	19.31413252	5.521254652	11.6860671	37
Data Point 2	61.56210394	12.31620642	4.612765023	10.50999646	10.49145531	50	18.63027463	4.865524408	11.01501586	35
Data Point 3	54.72606375	15.79158386	4.299960013	13.40783995	8.931950149	49	15.89155057	6.780725248	15.13658322	38
Data Point 4	65.74440625	17.59321228	5.248878493	13.21232354	15.19348539	58	13.01836015	6.704016165	13.18438498	33
Data Point 5	49.6351885	13.48482768	5.03068674	11.7503674	12.252861	46	16.2793235	6.748637506	13.45098313	36
Data Point 6	52.72693476	16.8825881	5.722141594	12.51479851	11.45454424	50	15.57534346	4.740040384	11.79360774	32
Data Point 7	61.0879491	17.26420781	5.689667408	9.203158366	12.73441028	53	14.06639045	5.492297151	11.3997372	31
Data Point 8	52.87996703	18.60224516	6.518341493	8.983913874	8.366091646	48	15.93302682	3.734396849	11.73907525	31
Data Point 9	49.31041025	11.21495385	3.870313645	12.49323308	14.88015047	46	13.61932909	4.646411931	12.72385129	31
Data Point 10	41.54842518	16.28475837	4.831135137	12.38871261	14.21832237	45	12.59199535	4.29614281	13.93987485	31
Data Point 11	64.94421186	17.00575809	5.463796268	9.802535715	15.11366718	56	17.55373427	6.568185485	10.79669254	35
Data Point 12	63.56803341	16.56801311	6.517564337	9.334713975	9.965998336	53	14.20304722	5.773016927	12.86351335	33
Data Point 13	53.77837339	17.24251215	6.327319228	8.357951122	9.418623906	48	11.01786012	5.995183417	11.38802424	28
Data Point 14	50.46403703	12.53567783	5.502198857	10.49234738	7.208733633	43	10.7565749	4.753687127	11.23718925	27
Data Point 15	54.61807022	14.85726179	6.133227659	12.81335106	10.37707933	49	16.28721683	6.236550393	10.50684826	33
Data Point 16	55.01534879	16.03188587	3.367931994	9.93818031	10.57518763	47	19.05031831	4.487379979	9.904177234	33
Data Point 17	57.35056905	13.55357421	4.92012591	13.60217251	12.52213254	51	13.28438904	5.679882577	9.434059772	28
Data Point 18	52.5358683	13.25446755	6.262899995	10.34477333	10.45004019	46	14.1811797	6.352262593	12.34641902	33
Data Point 19	46.55144827	13.23738182	6.000930559	11.19803545	11.28539061	44	14.72038493	6.047072599	8.829887151	30
Data Point 20	52.44020316	14.29313578	3.615178616	10.20039193	11.93367384	46	18.79289445	5.841876114	14.76372125	39
Data Point 21	58.8293017	15.5821945	6.124001102	12.4831414	14.20436753	54	13.16359301	5.241141656	12.26385235	31
Data Point 22	48.79520809	16.75927358	5.27610237	7.565764318	15.30614981	47	14.96072622	6.563137168	13.64008162	35
Data Point 23	49.52456438	12.32807038	4.089749331	11.32683232	10.07450681	44	13.60358869	5.024342837	9.020765287	28
Data Point 24	48.50974073	18.32071942	6.454248277	13.24143255	13.83487329	50	16.39696828	4.293644763	8.823388913	30
Data Point 25	46.11809922	12.68832062	5.549108834	12.44680168	10.40961355	44	12.47388919	6.008241555	11.51013633	30
Data Point 26	45.62810148	18.925344	5.953017702	9.61314159	15.23595002	48	17.19386161	4.674051536	12.80012276	35
Data Point 27	49.49101372	15.38635724	6.20875883	6.922887698	9.835461051	44	18.06604311	6.655978292	11.55594525	36
Data Point 28	52.54466731	17.19392784	6.232415179	7.110976829	12.8997765	48	18.23507425	4.629297126	10.78338183	34
Data Point 29	47.39851839	14.81392771	4.682629219	11.89371278	12.87753016	46	10.62423121	5.593140599	15.25241259	31
Data Point 30	56.74388172	16.65191148	5.676841018	13.48992865	13.6579701	53	16.63762582	4.640560642	12.28297689	34
Data Point 31	44.12659982	15.25281653	2.683119994	12.97083366	11.42077563	43	13.41595434	6.061219903	15.22496653	35
Data Point 32	52.98895353	14.43589395	5.113581689	10.15666724	14.41717434	49	16.11483447	6.65541602	13.27038925	36
Data Point 33	55.14024222	17.67386494	3.576717085	7.071698261	13.11483139	48	13.91146479	6.491408599	13.70800709	34
Data Point 34	52.81162361	15.4339684	4.93211294	10.77994743	13.48019094	49	15.30027496	4.216366743	11.81863724	31
Data Point 35	62.41643351	15.85204135	5.074098381	12.35831615	11.16990043	53	13.82740142	4.220572413	14.8465161	33
Data Point 36	35.71472615	14.27194829	6.119024658	11.64293136	10.86124007	39	13.30439366	4.74478367	11.90476374	30
Data Point 37	53.6378443	12.91376352	5.952149642	11.25716439	8.908648624	46	16.45280092	4.727859346	10.3045909	31
Data Point 38	47.7854651	15.07712144	4.601304718	11.45725848	11.13366533	45	16.55646461	5.652535475	12.88040301	35
Data Point 39	61.05413659	14.42805633	6.422817454	12.16395918	9.821463343	52	16.81284333	4.658029146	11.11312965	33
Data Point 40	44.02838039	15.17329126	6.476151765	9.822195106	11.9979887	44	18.13162814	5.099572678	11.79469973	35
Data Point 41	50.93465419	13.05147736	4.821906536	7.458672389	14.85796911	46	14.8913353	4.968120545	11.92494855	32
Data Point 42	60.57493131	16.15267487	5.443676495	11.56844495	12.15180169	53	18.79709579	5.930996344	14.46562302	39
Data Point 43	52.58492097	13.20775241	4.42668853	13.30040263	13.17224798	48	17.97005439	5.570791735	11.77368986	35
Data Point 44	37.58626005	11.62088631	5.862466756	11.74473491	10.20443899	39	13.25329999	4.928227359	14.21180683	32
Data Point 45	52.17171142	16.48900824	6.313063158	11.16259825	11.28447458	49	13.15124053	4.813143297	13.88294984	32
Data Point 46	36.89506022	18.41382523	6.172007507	8.554560667	14.51282456	42	15.06950555	6.195377271	12.47400168	34
Data Point 47	48.5077749	14.4734525	6.841744038	10.43288313	11.38317196	46	17.25403834	5.462651563	13.76785996	36
Data Point 48	60.39952537	16.18074118	4.948757334	10.40389969	14.75448861	53	15.04478775	4.819991518	9.955263475	30
Data Point 49	50.26883785	14.33290939	5.154468134	9.599808486	14.28968243	47	7.875651789	4.859607869	11.35687568	24
Data Point 50	58.35277376	10.93456513	6.256538034	9.453424942	14.63496284	50	16.08930408	5.153756567	11.222991	32
Data Point 51	63.03747246	17.484669	5.423347995	11.05317067	7.805917938	52	13.27051355	5.268122612	12.29960387	31
Data Point 52	43.3659141	7.307044877	5.079558674	13.5821175	14.90460436	42	14.66160803	3.707332778	12.71937543	31
Data Point 53	53.81723693	13.96541855	6.420904506	7.893261517	11.29189505	47	16.10724451	4.58206438	9.485994363	30
Data Point 54	45.93252003	10.51853619	6.530752862	11.3483252	15.10450251	45	14.13320457	6.233951849	13.93350859	34
Data Point 55	41.98419952	12.33587102	4.204792612	10.32113282	12.76269608	41	12.06927453	4.867822684	12.2361971	29
Data Point 56	49.30527549	17.43993282	5.537247409	11.3121577	14.94614923	49	14.2266688	5.43718757	14.71704874	34

STEP 3: EXAMINE STATISTICAL RESULTS

Summary Statistics for Medsurv

Sample Size (*N*): 10000

Central Tendancy (Location)

Mean:	47	**Median:**	47.51
StErr:	0.04		

Spread

StDev:	4		
Max:	59	Q(.75):	51
Min:	30	Q(.25):	44
Range:	29	**IQ Range:**	-95

Shape

Skewness:	-0.26
Kurtosis:	-0.19

Quantiles, Percentiles, Intervals

	90% Interval		**95% Interval**
Q(.05):	40	Q(.025):	38
Q(.95):	54	Q(.975):	55

Summary Statistics for RFA

Sample Size (*N*): 10000

Central Tendancy (Location)

Mean:	33	**Median:**	32.62
StErr:	0.03		

Spread

StDev:	3		
Max:	41	Q(.75):	35
Min:	19	Q(.25):	30
Range:	22	**IQ Range:**	-65

Shape

Skewness:	-0.22
Kurtosis:	-0.15

Quantiles, Percentiles, Intervals

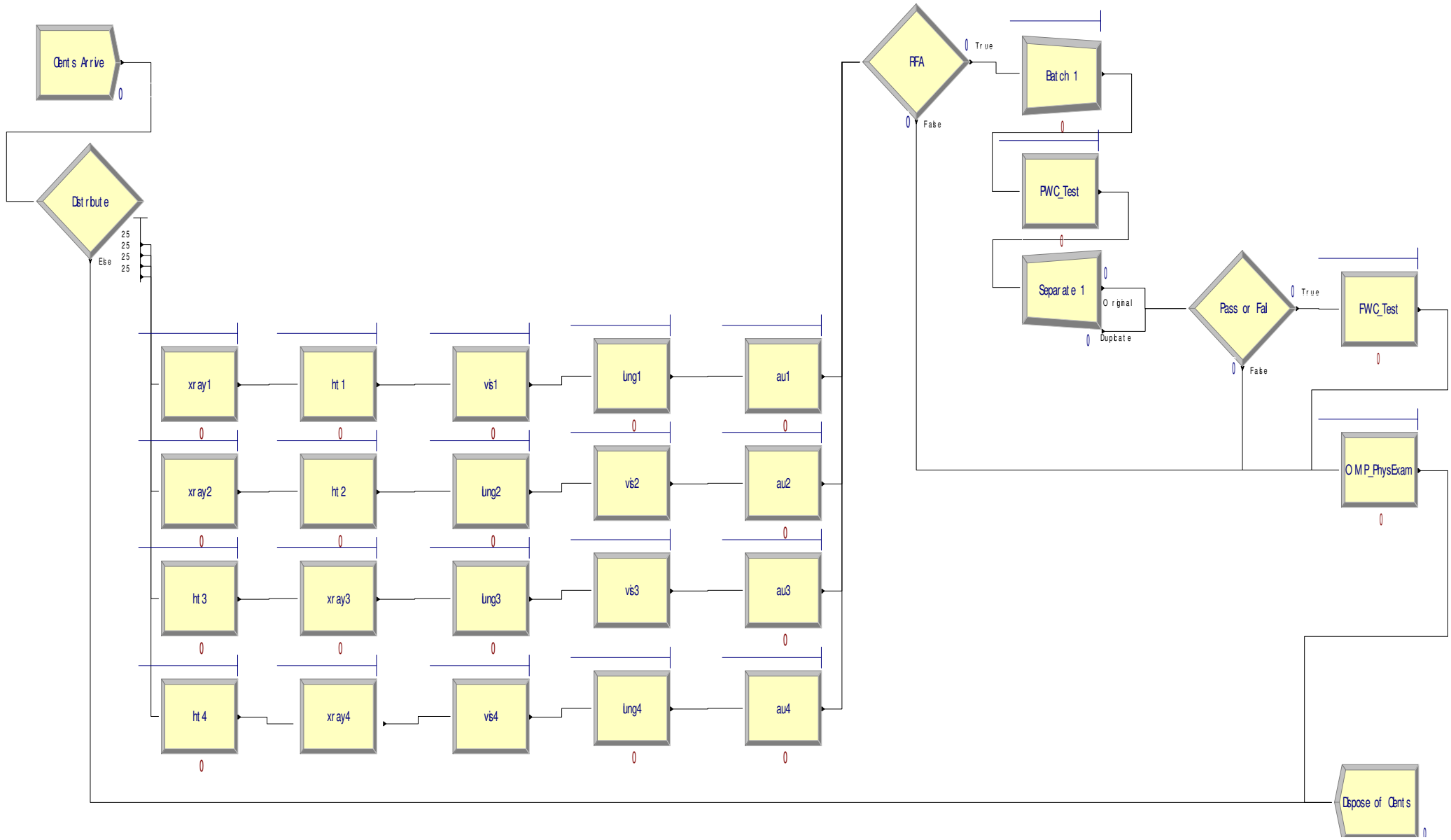
	90% Interval		**95% Interval**
Q(.05):	27	Q(.025):	26
Q(.95):	38	Q(.975):	38

ANNEXURE C: BREAKDOWN OF DAILY SCHEDULE

TIME OF DAY	Clerk	Cleaner	Radiographer	OHA	Paramedic	OT	OMP
7:00	Arrive at OHC Team meeting	Arrive at OHC Team meeting	Arrive at OHC Team meeting	Arrive at OHC Team meeting	Arrive at OHC Team meeting	Arrive at OHC Team meeting	Arrive at OHC Team meeting
7:15	Receive clients, hand over client cards and direct to stations	Cleaning of toilets	Continual Operate X-ray Medsurv testing untill all clients were completed.	Operate Medsurv/PWC tests	Prepare for Medsurv tests	Prepare for PWC testing	Consult Medsurv clients
7:30	Receive clients, hand over client cards and direct to stations	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
7:45	Receive clients, hand over client cards and direct to stations	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
8:00	Receive clients, hand over client cards and direct to stations	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
8:15	Administration	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
8:30	Administration	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
8:45	Administration	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
9:00	Receive clients, hand over client cards and direct to stations	Clean kitchen/tea room	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
9:15	Administration	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
9:30	Administration	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
9:45	Receive clients, hand over client cards and direct to stations	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
10:00	TEA BREAK						
10:15	Administration	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
10:30	Administration	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
10:45	Administration	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
11:00	Receive clients, hand over client cards and direct to stations	Cleaning of RFA equipment/area	X-rays	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	PWC Consult/testsing	Consult Medsurv clients
11:15	Administration	Cleaning of RFA equipment/area	Ordering of OHC stock	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	Adminstration	Adminstration
11:30	Administration	Cleaning of RFA equipment/area	Ordering of OHC stock	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	Adminstration	Adminstration
11:45	Administration	Cleaning of RFA equipment/area	Ordering of OHC stock	Conduct Medsurv/PWC testing	Conduct Medsurv/PWC testing	Adminstration	Adminstration
12:00	RFA - FWC testing	Cleaning of all stations	RFA - FWC testing	Administrative	Adminstration	RFA - FWC testing	Adminstration
12:15	RFA - FWC testing	Cleaning of all stations	RFA - FWC testing	Administrative	Adminstration		Adminstration

TIME OF DAY	Clerk	Cleaner	Radiographer	OHA	Paramedic	OT	OMP
12:30	RFA - FWC testing	Cleaning of all stations	RFA - FWC testing	Administrative	Adminstration		Adminstration
12:45	RFA - FWC testing	Cleaning of all stations	RFA - FWC testing	Administrative	Adminstration		Adminstration
13:00	LUNCH						
13:30	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
13:45	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
14:00	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
14:15	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
14:30	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
14:45	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
15:00	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
15:15	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
15:30	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
15:45	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients
16:00	RFA - FWC testing	Cleaning of toilets	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	RFA - FWC testing	Consult Medsurv clients

ANNEXURE D: ARENA SIMULATION MODEL


Clients Arrive
Distribute
25
25
25
25
Else
xray1
ht1
vis1
lung1
au1
xray2
ht2
lung2
vis2
au2
ht3
xray3
lung3
vis3
au3
ht4
xray4
vis4
lung4
au4
PFA
True
False
Batch 1
PWC_Test
Separate 1
Original
Duplicate
Pass or Fail
True
False
FWC_Test
OMP_PhysExam
Dispose of Clients

ANNEXURE E: CLIENT TESTING QUANTITY

ARRIVAL AND TESTING OF CLIENTS									
	X-RAY	BLOOD,URINE, HISTORY	VISION	LUNG	AUDIO	PWC	FWC	PHYSICAL EXAM	
Cycle Time (min)	7	7	8	4	11	61	50	13	
TIME PERIOD									
7:00							2	1	FOLLOW-UPS
7:05									
7:10								1	
7:15									
7:20								1	
7:25									
7:30								1	
7:35									
7:40							2	1	
7:45									
7:50								1	
7:55									
total tested	0	0	0	0	0	0	4	6	
8:00	1	1	1	1	4				
8:05	1			1				1	
8:10	1	1	1	1					
8:15	1			1				1	
8:20	1	1	1	1	4		2		
8:25	1	1	1	1				1	
8:30	1	1	1	1					
8:35	1			1				1	
8:40	1	1	1	1	4	10			
8:45	1			1				1	
8:50	1	1	1	1					
8:55	1	1	1	1				1	
total tested	12	8	8	12	12	10	2	6	
9:00	1	1	1	1	4		2	1	
9:05	1			1					
9:10	1	1	1	1				1	
9:15	1			1					
9:20	1	1	1	1	4	10		1	
9:25	1	1	1	1					
9:30	1	1	1	1				1	
9:35	1			1					
9:40	1	1	1	1	4		2	1	
9:45	1			1					
9:50	1	1	1	1				1	
9:55	1	1	1	1					
total tested	12	8	8	12	12	10	4	6	
10:00	TEA BREAK								
10:15	1			1	4	10		1	/ CLIENTS
10:20	1	1	1	1					
10:25	1			1				1	
10:30	1	1	1	1					
10:35	1			1				1	

ARRIVAL AND TESTING OF CLIENTS								
	X-RAY	BLOOD,URINE, HISTORY	VISION	LUNG	AUDIO	PWC	FWC	PHYSICAL EXAM
Cycle Time (min)	7	7	8	4	11	61	50	13
TIME PERIOD								
10:40	1	1	1	1			2	
10:45	1	1	1	1	4			1
10:50	1	1	1	1				
10:55	1			1				1
total tested	9	5	5	9	8	10	2	5
11:00	1	1	1	1				1
11:05	1			1	4			
11:10	1	1	1	1				1
11:15	1	1	1	1				
11:20	1	1	1	1			2	1
11:25	1			1	4			
11:30	1	1	1	1				1
11:35	1			1				
11:40	1	1	1	1				1
11:45	1	1	1	1	4			
11:50	1	1	1	1				1
11:55	1			1				
total tested	12	8	8	12	12	0	2	6
12:00	1	1	1	1			2	
12:05	1			1	4			1
12:10	1	1	1	1				
12:15	1	1	1	1				1
12:20	1	1	1	1				
12:25	1			1	4			1
12:30	1	1	1	1				
12:35	1			1				1
12:40	1	1	1	1			2	
12:45	1	1	1	1	4			1
12:50	1	1	1	1				
12:55	1			1				1
13:00	1	1	1	1				
total tested	13	9	9	13	12	0	4	6
TOTAL	58	38	38	58	56	30	18	35
LUNCH								
14:00							4	3
14:30							4	3
15:00							4	3
15:30							4	3
16:00							4	3
total tested							20	15
GRAND TOTAL	58	38	38	58	56	30	38	50

MEDSURV

RFA CLIENTS

ANNEXURE F: ALTERNATIVE DESIGNS OF FACILITY

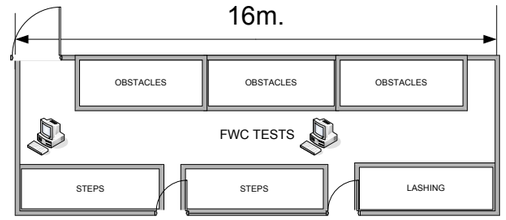
OCCUPATIONAL HEALTH CENTRUM FLOOR LAYOUT
12 August 2009

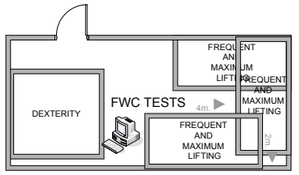
OCCUPATIONAL HEALTH CENTRUM

ALTERNATIVE 1 AND 2 FLOOR LAYOUT

NOTE
Alternative 1 Varies with Alternative 2 in that Alt 1 has the PWC in a container and Alt 2 PWC is builtd

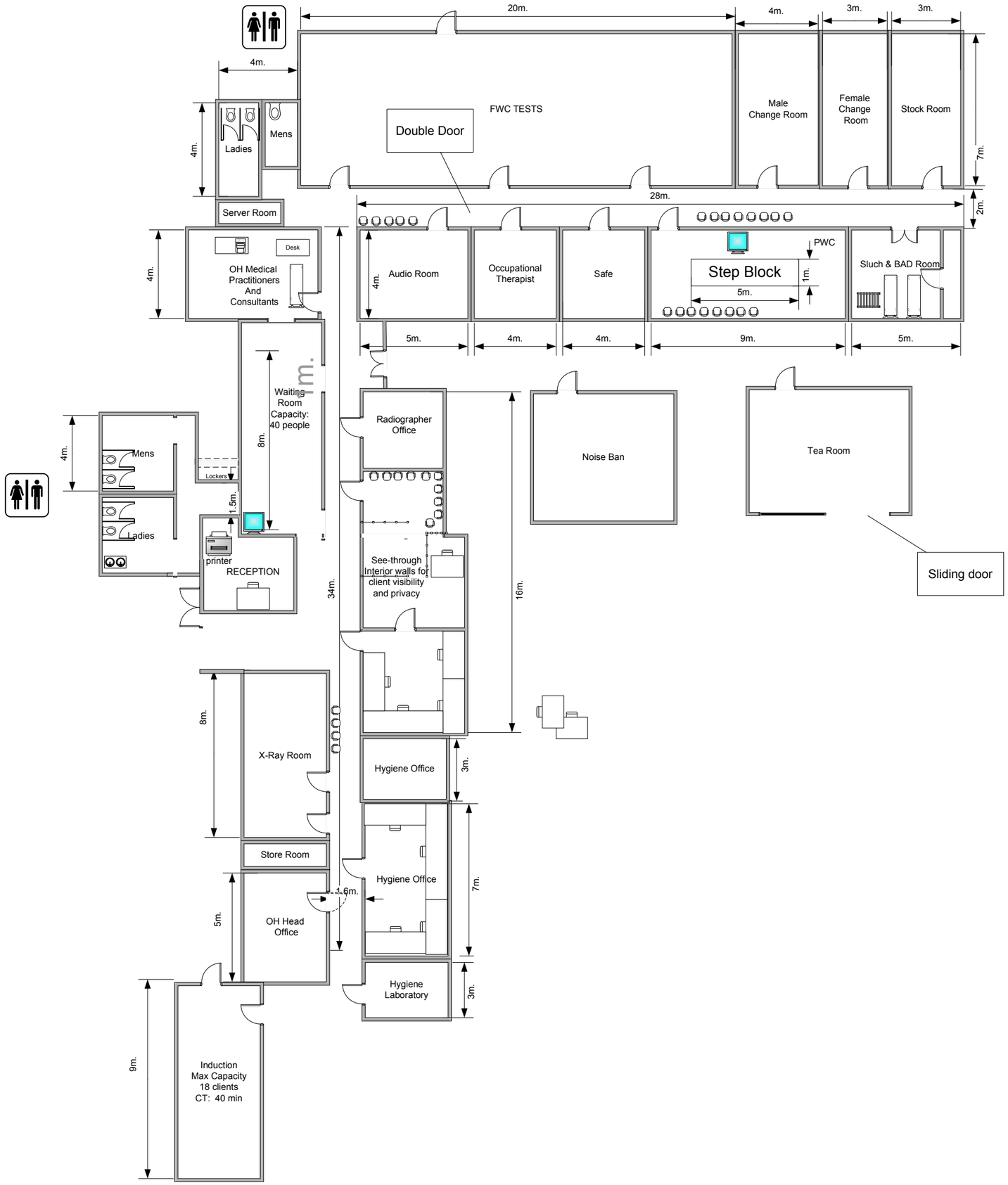
FWC Test Area Requirement





OCCUPATIONAL HEALTH CENTRUM

ALTERNATIVE 3 FLOOR LAYOUT



FWC Test Area Requirement