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CHAPTER TWO

HUMAN RESOURCE PLANNING

TO SUPPORT OPERATIONAL REQUIREMENTS

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1. INTRODUCTION

1.1 The Planning Process

1.1.1 A human resource planning methodology is required to meet the operational needs for skilled personnel, on a day-to-day basis. The process is essentially a tactical planning process involving staff at all levels of an organization including; senior management, supervisors and workers. This chapter describes the basic elements of a tactical human resource planning process. The basic elements are operational factors, staffing factors, and the rostering of personnel (covered in Chapter 3). As can be seen in Figure 1, the results of the planning process are also used to forecast the demand for skilled human resources. The results of the process can be affected by a change in technology.

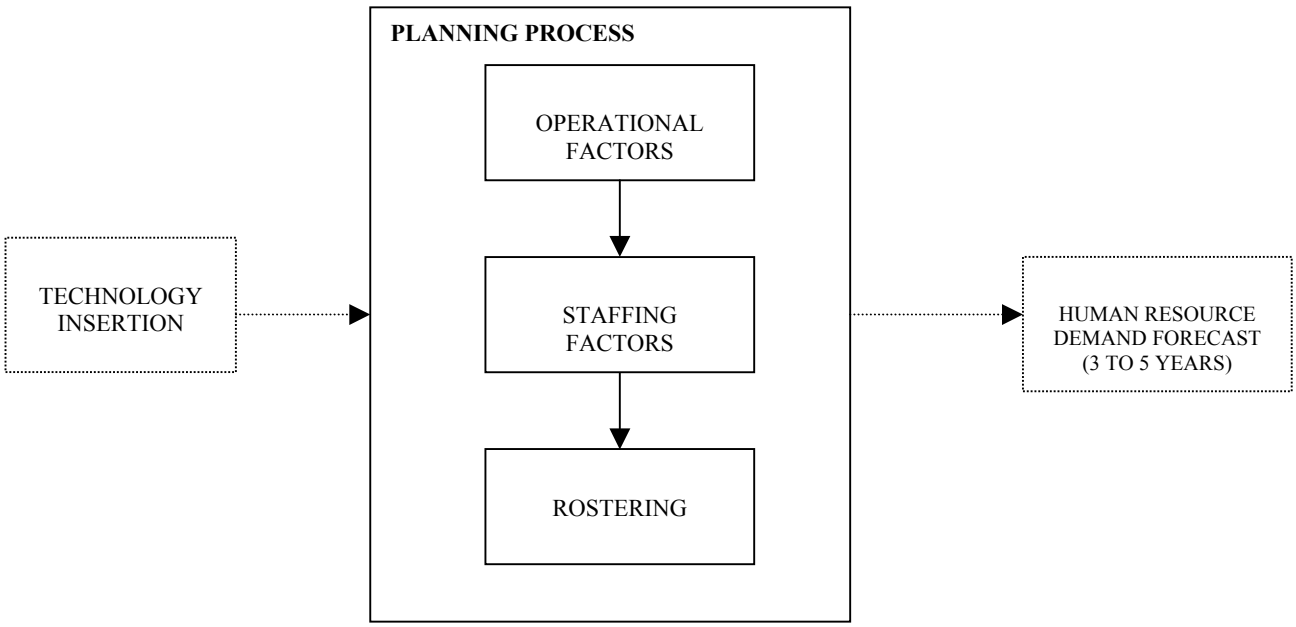


Figure 1 Planning Process

> ***Tactical human resource planning*** *is a process that ensures that an operational organization has sufficient skilled human resources to meet existing operational requirements in accordance with the organization policy.*

1.2 Evaluate the Organizational Activities

1.2.1 The first step in a tactical human resource planning process is to assess the organizational activities in order to quantify the human resources needed to meet those requirements. This is done for each service provided by an organization. For example, for air traffic control this involves the evaluation of traffic demand, airspace structure, distribution and mix of traffic over various time frames. The number of positions/sectors required is based on the traffic volume and its complexity. The operational activities (the opening and closing times for each position/sectors) will then determine the staff requirements.

1.2.2 A similar evaluation for maintenance engineering would take into account the preventive maintenance cycle along with corrective maintenance estimates and planned equipment modifications. The total number of maintenance hours per year is one of the primary factors to determine staff requirements.

1.2.3 The number of staff needed to meet operational requirements is not only based on the total number of activity hours in the planning period but also on other factors such as in service training, conditions of service and the rostering cycle. In addition, not all air traffic control positions/sectors will always be staffed on a 24-hour basis. On the other hand, there may be safety requirements that would necessitate a 24-hour coverage of some maintenance activities and other aeronautical functions.

1.2.4 The following paragraphs primarily describe the human resource planning process for air traffic control In addition, a CNS (communications, navigation and surveillance) maintenance division is described. The methodologies outlined can be adapted for other aeronautical disciplines.

OPERATIONAL FACTORS

> ***Operational*** *factors determine the human resources required to maintain the operational function of a facility. For example, the number of sectors and workload in each sector are some of the operational factors for an area control centre. Hours of operation would be a major operational parameter for a technical facility.*

2.1 General

2.1.1 Major factors to be considered when developing a tactical human resource plan for an air traffic control facility are the airspace organization and the controller workload. Here we deal with the operational factors of an intended airspace and the associated controller workload.

2.2 Airspace capacity

2.2.1 The capacity of an ATS system depends on many factors, including the ATS route structure, the navigation accuracy of the aircraft using the airspace, weather related factors, and controller workload.

2.2.2 The number of aircraft provided with ATC service should not exceed that which can be safely handled by the ATC unit concerned under the prevailing circumstances. In order to define the maximum number of flights that can be safely accommodated, the appropriate ATS authority should assess and indicate the ATC capacity for control areas, for control sectors within a control area and for aerodromes. ATC capacity is normally expressed as the maximum number of aircraft that can be accepted over a given period of time within the airspace or at the aerodrome concerned.

2.2.3 The most appropriate measure of capacity is likely to be the sustainable hourly traffic flow. Such hourly capacities can, for example, be converted into daily, monthly or annual values.

2.2.4 In assessing capacity values, factors to be taken into account should include:

a) the level and type and mix of traffic;
b) the structural complexity of the control area, the control sector or the aerodrome concerned;
c) the types of communications, navigation and surveillance systems in use, their degree of technical reliability and availability as well as the availability of back-up systems and/or procedures;
d) availability of ATC systems, providing controller support and alert functions; and
e) any other factor or element deemed relevant to controller workload.

2.2.5 Data gathered should be as detailed and precise as possible, taking into account seasonal peaks and weather conditions. These are factors that can have an impact on staffing and rostering. The expected traffic volume during a single day and on an hourly basis determines the opening, and closing times of working positions and where appropriate sectors. A given airspace may be divided into multiple sectors with each sector consisting of possibly one or more control positions. The objective of opening or closing a sector is to ensure a safe, efficient and orderly traffic flow.

2.3 Airspace organization

2.3.1 The solution to human resource shortages is not always adding additional staff. A re-arrangement of airspace can result in significant efficiencies, which in turn may reduce the number of staff required.

2.3.2 The organization of a given airspace, its division into sectors, the number of control positions in these sectors, the opening /closing times of positions together with present and predicted traffic volume are all important human planning factors to be considered. The configuration of the airspace should be broken down into and should take account of:

- number of ATS routes served;
- number of intersections of ATS routes;
- number of major terminal areas and total number of aerodromes (including military) in the area;
- proportions of aircraft in level flight and in climb or decent;
- airspeeds and levels used by groups of aircraft constituting a significant portion of the total traffic.

2.3.3 The technical infrastructure of a given airspace can have a profound effect on human resource needs. There are many technology-related questions to be asked, some of them are:

- What kind of technical co-ordination is required between the different units, for example, six units, which include one upper airspace control centre (UACC), four area control centres (ACCs) and one airport?
- To what extent should that coordination make use of new technologies?

2.4 Air Traffic Controller Workload

2.4.1 The air traffic controller's capacity is related to his or her capability to manage traffic The more aircraft that are handled, the greater the capacity. In order to estimate the controller capacity and in turn workload, it is necessary to gather data on the airspace organization as detailed in paragraph 2.2 above. Values of ATC workload should naturally be co-ordinated between the needs of operations staff and human resource planning. However, in practice, human resource planners cannot take into account solely the capacity/workload factor, because sector organization also effects the controller workload.

2.4.2 A method to determine a specific function of air traffic controller workload is outlined in the Air Traffic Services Planning Manual (Doc 9426-AN/924).[1] The manual contains a summary of techniques for ATC sector/position capacity estimation. It focuses on the tasks, carried out by the air traffic controller and the workload estimated by summing the time spent on individual tasks.

2.4.3 The method used was the "DORATASK" [2] approach. The workload assessment was carried out at a radar controller position. The workload results were obtained by summing the time spent on routine and conflict resolution (observable) tasks, and planning (non-observable) tasks. In addition to these two interrelated elements of the controller's tasks, there was a third element – a "recuperation" time. This was the proportion of time not allocated to any specified tasks (observable or non-observable) but considered essential for the safe operation of the sector.

2.4.4 It should be noted, that the method outlined above, provides capacity estimates that apply only to the conditions of equipment, staffing, traffic patterns, etc. which prevailed during the observations. To assess controller capacity under a different airspace environment, with different equipment or procedures, and different traffic loading, a new survey will be necessary.

2.4.5 A definition of controller capacity/workload after using the methods similar to those outlined in the Air Traffic Services Planning Manual (Doc 9426-AN/924) can be stated as:

[1] Air Traffic Services Planning Manual (Doc 9426-AN/924), Part II. – Methods of application employed by Air Traffic Services, Section 1, Chapter 1. – Air traffic flow management and flow control. Appendix C, Techniques for ATC Sector/Position Capacity Estimation. (11-1-1-12)

[2] The United Kingdom DORATASK models were used to assess the capacity of airspace sectors and to determine constraints on traffic throughput in both terminal areas and en-route airspace.

> **Controller Capacity** can be defined as the number of aircraft that can be handled by a controller within a certain period of time for a given sector size, taking into account observable and non-observable tasks, plus any additional time which provides the controller a safe margin for recuperation.

2.4.6 It should be emphasised that controller capacity/workload is likely to vary among the different air traffic control positions and among individual controllers. Airspace capacity also differs among different control environments. These differences should be taken into account in any evaluation of controller capacity/workload.

2.5 Workload, a function of traffic flow

2.5.1 As stated previously, in order to estimate the controller workload, it is necessary to obtain data on the FIR geographical area and the traffic loading. However, human resource planners cannot take into account solely a workload factor, because the demand depends on the sector organization.

2.5.2 The data from operations will indicate when a sector should be opened, when it should be closed and what the expected throughput is. Afterwards, it is up to human resource planners to identify staff that will work in the sectors and at what times.

2.5.3 Controller workload can easily change as a function of traffic flow. When traffic builds up in the early hours of the morning, for example, with the arrival of specific international flights, workload can increase from a level of, 60% to 90% of what could be considered the maximum levels as determined. There may also be a build-up of routine domestic traffic at the same time. Determining the exact level of controller workload is a complex task. There are qualitative issues such as traffic mix that can be stressful or a relief, depending on the context, to the quantitative traffic volumes. Air traffic controllers differ in their age and health, which could affect their stress and perceived workload levels. In most cases, expert controller opinions, or a combination of consulting a representative association and expert controller assessment of the traffic conditions can revalidate the workload estimation.

2.6 Fast-time Modelling

2.6.1 It is possible to use fast-time modelling techniques, based on models of controller workload with varying degrees of sophistication, for example, covering different tasks. Basically, fast-time modelling is used to build up a function, on a sector-by-sector basis, relating number of aircraft to workload. Then, some workload threshold is used to define what can be termed as the “controller capacity”.

2.6.2 Some organizations use a method, which provides maximum and minimum data, presented in high-low charts. The workload is defined in terms of a maximum percentage of time, where the average workload is at a certain level and a peak that can reach a higher figure.

2.7 Communication, Navigation, Surveillance (CNS) Support Section Workload

2.7.1 In order to determine the workload of a CNS maintenance support section it is first necessary to obtain a complete inventory list of all equipment and facilities that need to be supported. This list should include historical data such as date of installation/commissioning, records of modifications and maintenance. Along with the manufacturer recommendations for preventative and corrective maintenance programmes, it should then be possible to draft a task-load factor for each individual equipment/facility.

Appendix B provides a methodology for determining the staffing factor, while Chapter 8 includes a case study, which gives detailed analysis for the staffing of a hypothetical CNS section.

3. STAFFING METHODOLOGY

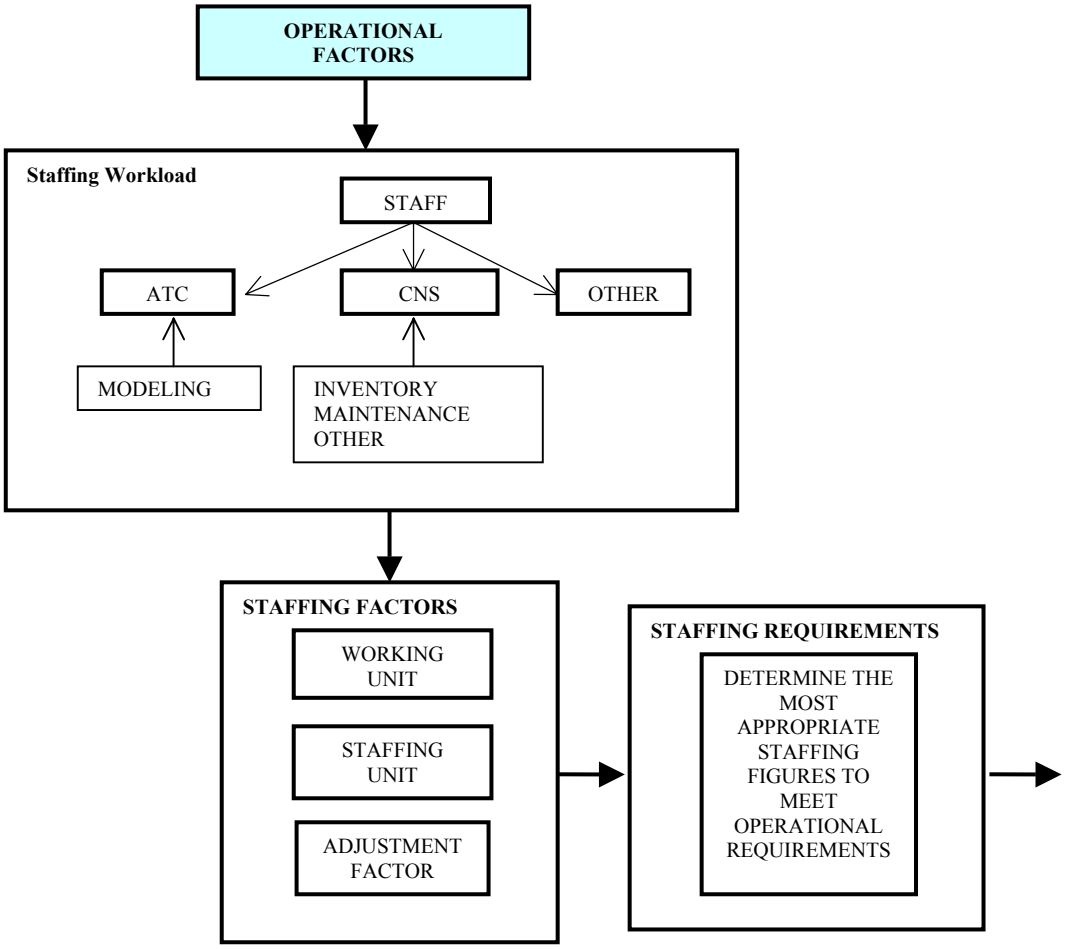


Figure 2, Process for determining staffing needs

3.1 General

3.1.1 The operational requirements and the resulting workload factors are utilized to determine the staffing requirements.

3.1.2 The main purpose of any staffing methodology is to determine the number of personnel required to perform the core tasks of an organization (for example, the provision of air traffic services). The approach differs between determining the numbers of air traffic controllers needed and the demand for technical staff. Due to the fluid workload requirements, a more complex approach is often required to determine the staffing and subsequent rostering needs for air traffic controllers. However, for other

aeronautical services, due to a more static nature of the workload this methodology with some adjustments may be used.

3.1.3 Figure 2 outlines the process for achieving staffing requirements. The principles outlined in the following paragraphs are guidelines for the staffing of an air traffic control facility and that of an electronic maintenance facility. The approach used for electronic maintenance facility (also known as the CNS maintenance facility) with some adjustments can be used for other units/facilities such as the AIS and Crash Rescue Fire Service. Chapter 8, Case Study demonstrates the use of these principles.

3.2 Evaluation of workload

3.2.1 The next step in the human resource planning process is to evaluate the quantity of work to be undertaken to support the required operational procedures and facilities. This approach can vary dramatically depending on the complexity of the operational requirements. A more detailed approach to this subject is included in Appendices A and B to this chapter.

4. WORKING UNIT AND STAFFING FACTOR – DETERMINE MINIMUM STAFFING REQUIREMENTS

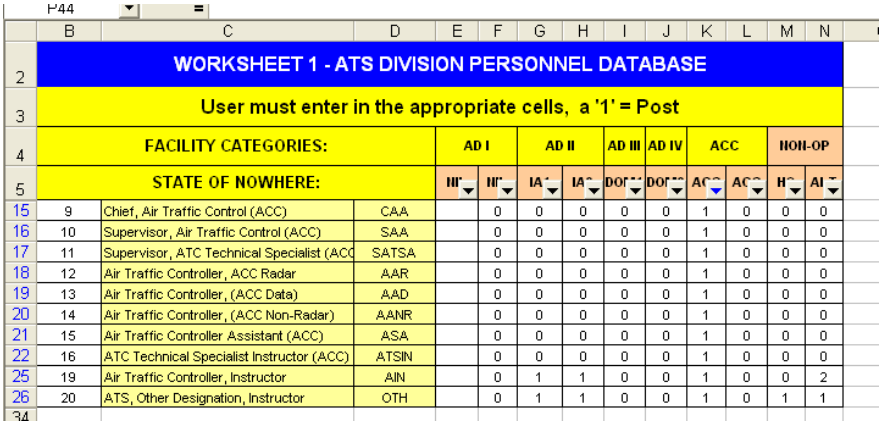
The "*Working Unit*" is the hours per year a person is available to work. This definition is based upon the effective working hours per day and the effective workdays per year.

The "*Operational Staffing Factor*" is a figure representing the minimum number of staff to cover a work function (such as an ATC workstation or maintenance for a navigational aid facility) for a specified period of operation. It does not take into consideration any specific factors (i.e., rostering, special operational requirements). The mathematical figure is derived from the total operational hours in one year and the calculated *working unit.*

4.1 Preparing data for Air Traffic Controller staffing calculations (*Worksheets 1 and 2*)

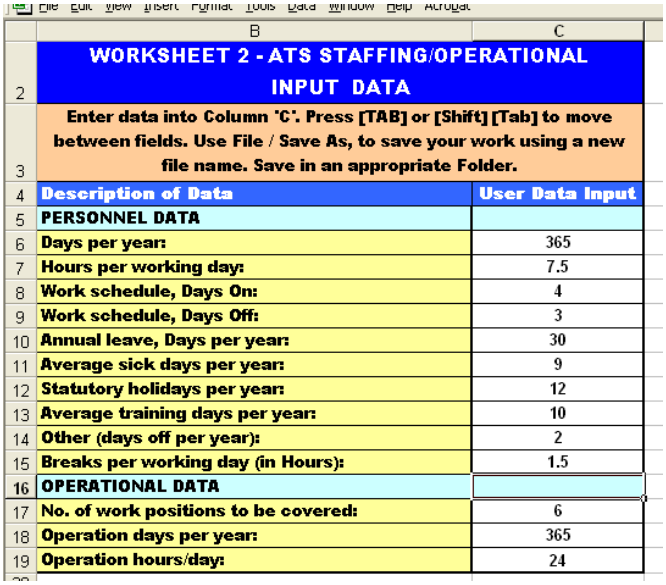
4.1.1 The initial step is to obtain (or produce) a listing of all the ATC post designations. This can be a paper exercise or use an electronic spreadsheet. Figure 3 (Worksheet 1) is a sample of such a spreadsheet.

4.1.2 The second step in the process for calculating staffing figures, is to obtain and record personnel working conditions data and specific operational data. Figure 4 (*Worksheet 2*) illustrates the "Staffing and Operational Input Data" worksheet. All required information has been entered into cells "C6" … "C19" all other cells of the worksheet are locked-out. The worksheets used are from a Microsoft Excel Workbook.



	B	C	D	E	F	G	H	I	J	K	L	M	N
2	WORKSHEET 1 - ATS DIVISION PERSONNEL DATABASE												
3	User must enter in the appropriate cells, a '1' = Post												
4	FACILITY CATEGORIES:			AD I		AD II		AD III	AD IV	ACC		NON-OP	
5	STATE OF NOWHERE:			III	III	IA	IA	DOT	DOT	ACC	ACC	HQ	AI
15	9	Chief, Air Traffic Control (ACC)	CAA		0	0	0	0	0	1	0	0	0
16	10	Supervisor, Air Traffic Control (ACC)	SAA		0	0	0	0	0	1	0	0	0
17	11	Supervisor, ATC Technical Specialist (ACC	SATSA		0	0	0	0	0	1	0	0	0
18	12	Air Traffic Controller, ACC Radar	AAR		0	0	0	0	0	1	0	0	0
19	13	Air Traffic Controller, (ACC Data)	AAD		0	0	0	0	0	1	0	0	0
20	14	Air Traffic Controller, (ACC Non-Radar)	AANR		0	0	0	0	0	1	0	0	0
21	15	Air Traffic Controller Assistant (ACC)	ASA		0	0	0	0	0	1	0	0	0
22	16	ATC Technical Specialist Instructor (ACC)	ATSIN		0	0	0	0	0	1	0	0	0
25	19	Air Traffic Controller, Instructor	AIN		0	1	1	0	0	1	0	0	2
26	20	ATS, Other Designation, Instructor	OTH		0	1	1	0	0	1	0	1	1

Figure 3 (*Worksheet 1*) "*ATS personnel list of designations*"



	B	C
2	WORKSHEET 2 - ATS STAFFING/OPERATIONAL INPUT DATA	
3	Enter data into Column 'C'. Press [TAB] or [Shift] [Tab] to move between fields. Use File / Save As, to save your work using a new file name. Save in an appropriate Folder.	
4	**Description of Data**	**User Data Input**
5	**PERSONNEL DATA**	
6	**Days per year:**	365
7	**Hours per working day:**	7.5
8	**Work schedule, Days On:**	4
9	**Work schedule, Days Off:**	3
10	**Annual leave, Days per year:**	30
11	**Average sick days per year:**	9
12	**Statutory holidays per year:**	12
13	**Average training days per year:**	10
14	**Other (days off per year):**	2
15	**Breaks per working day (in Hours):**	1.5
16	**OPERATIONAL DATA**	
17	**No. of work positions to be covered:**	6
18	**Operation days per year:**	365
19	**Operation hours/day:**	24

Figure 4 (*Worksheet 2*) Input data for "*ATS Staffing Data Analysis*"

4.2 Automatic staffing factors calculations (Worksheet 3)

4.2.3 If *Worksheet 2* (ATS Staffing/Operational Input Data) is used in association with Figure 5 (*Worksheet 3),* ATC Facility Staffing Data, the data from *Worksheet 2* will be automatically cross-linked to *Worksheet 3* with no inputs to *Worksheet 3* required by the user.

4.2 Determine the effective working hours

4.2.1 Human resource planners will need to determine the "effective working hours" of staff members during a single year period taking into account such items as annual leave, sick leave, days off, public holidays and training, etc. Once all of the relevant data is obtained, an "Operational Staffing Factor" is calculated based on the total operational hours per year and other relevant data. Another Microsoft Excel Worksheet has been utilized to calculate the pertinent data. *Worksheet 3* (in the same Excel Workbook as

Worksheet 2) and illustrated in Figure 5, is an example of how the calculations are made to arrive at a *"Staff Work Unit*" and the "Operational *Staffing Factor*". The example can be applied to all categories of aeronautical disciplines where this data is deemed necessary. All calculations within *Worksheet 3* are automatic, no user input is required on this worksheet. The examples used are generic and do not represent any specific conditions. The user is only able to enter data into the data input cells, all other cells of the worksheet are locked-out.

4.2.2 The worksheet is intended as a template, from which data may be inserted as variables related to an organization's policies and procedures. Appendix A to this chapter provides a detailed example of an analysis for air traffic controller staffing of a three-sector area control centre, including the opening and closing times of the three sectors. Appendix B provides a sample analysis for an electronic maintenance unit.

	B	C	D	E	F	G	H	I
2	**WORKSHEET 3A - ATS FACILITY STAFFING DATA**							
3	**User data from WS-2 Input ATS**							
4	**There is NO User data entry into this Worksheet**							
5	**STAFF WORKING DATA**							
6	**Data inputted from Data Table**					**Input Data**		
7	Hours per working day (ex. 7:30 Hrs = 7.5 decimal):					7.5		
8	Work schedule, days on (ex. 5 on, 2 off):					4		
9	Work schedule, days off:					3		
10	Annual leave per year:					30		
11	Average sick days per year:					9		
12	Statutory holidays per year:					12		
13	Average days for training per year					10		
14	Other days Off (not specified)					2		
15	Breaks per day in hours (briefing, rest etc.)					1.5		
16	**Work week adjustment factor (days on/days off).**							
17	*Adjustment factor =*				*G9 / G8+G9*		0.43	
18								
19	Days per calendar year			365				
20	Total hours per year:			*24*	(E19xE20)		*8766*	*hours*
21	Effective available working hours per day				(G7-G15)		*6.66*	*hours*
22	Days off per year (duty rotation)			*156.43*	*function of E19 & (H17)*			
23	Other days off (sum G10, G11, G12, G13 & G14))			*63.00*				
24	Total non-operational days				(E22+E23)		*219.43*	*days*
25	Available operational work days per year				(E19-H24)		*145.57*	*days*
26	**Staff Working Unit**							
27	Available operational work hours per year				(H21*H25)		*873*	*hours*
28	**OPERATIONAL STAFFING DATA**							
29	Operational hours per day						24	*hours*
30	Operational days per year						365	*days*
31	Total facility operational hours per year				(H29*H30)		8760	*hours*
32	Operational staffing factor for the facility				(H31/H27)		**10.03**	
33	Minimum annnual staffing requirement for one position (staffing factor)						**10**	*rounded*
34	Minimum Annual staffing requirement for "x" facilities					**6**		
35	Number of positions x Operational staffing factor				(G34xH32)		60.18	
36	Minimum staff required fc		6	positions		*(Round)*	**60**	*staff*
37								
38								

Figure 5 (*Worksheet 3A*) – Sample of Personnel Staffing Data Worksheet

	B	C	D	E	F	G	H	I
38	**WORKSHEET 3B - SUMMARY OF RESULTS**							
39	**DETERMINE STAFF WORKING UNIT**							
40	Total hours per year (H20)			H20			**8760**	**hours**
41	Effective available working hours per day (G7-G15)			H21			**6.00**	**hours**
42	Days off per year (due to shift rotation)			E22			**156**	**days**
43	Other days off (sum G10, G11, G12, G13 & G14)			E23			**63.00**	**days**
44	Total Non-operational days (sum E42, E43)			H24			**219**	**days**
45	Available work days per year (E19 - H24)			H25			**146**	**days**
46	Available work hours per year: (H21 x H25)			H27			**873**	**hours**
47								
48	**OPERATIONAL STAFFING DATA (staffing factor)**							
49	Operational hours per day			H29			**24**	**hours**
50	Operational days per year			H30			**365**	**days**
51	Total facility operational hours per year (E19*E20)			H31			**8760**	**hours**
52	Operational staffing factor for the facility = H31/H27			H32			**10.03**	***SF***
53	Minimum annnual staffing requirement for one position						**10**	**rounded**
54	**Minimum Annual staffing requirement for "x" facilities**							
55	Minimum staff required for		**6**	positions		(Round)	**60**	**staff**
56								

Figure 6 (*Worksheet 3B*) – Summary of results obtain from *Worksheet 3A*

4.3 Figure 5, *Worksheet 3A* - Output Data

4.3.1 On completing the entry data in *Worksheet 2* (Figure 4), output data is automatically obtained from *Worksheet 3A* (Figure 5). Figure 6 provides a summary version of the data produced

4.3.2 Figure 6, shows the "*staff working unit*", the "*operational staffing factor*" and the minimum staff required to occupy one position (function). These figures are automatically produced in *Worksheet 3*. The minimum staffing for multiple positions (6) are also shown.

4.3.3 The *"Adjustment Factor"* (Cell H17 of Worksheet 3A) is a function of the number of days a shift period will cover (for example 7) and the number of days that are required to be worked by an individual (for example 4). This would represent a work week (four days on three days off). If the shift schedule were to be six days on and three days off (or any other different combination), the adjustment factor would provide a different result.

4.4 Worksheet 3 – Minimum staff requirements

4.4.1 The result in Figure 6 (*Worksheet 3B*) of 60 minimum staff required to man six positions is based on working conditions only. These figures do not take into account any specific requirement for staff coverage for operational factors such as, the opening and closing times of airspace sectors. These calculations are useful where there are static operational working conditions such as a facility that has fixed operational hours with a fixed number of positions to staff. The maintenance of communications facilities at an airport or staffing the AIS section are examples where this type of data could be used directly from the worksheets 2 and 3. In order to estimate the staffing needs of, for example an en-route area control centre, it is necessary to undertake a detailed analysis as outlined in the previous sections of this chapter. However, it is still necessary to utilize *Worksheet 2* and *Worksheet 3* to obtain the "*staffing work unit*" and the "*operational staffing factor*" which are required for the more detailed analysis.

4.5 Practical human resource availability

4.5.1 There is always the need for human resource planners to gather, on an ongoing basis, data related to actual human resource availability. For example, in determining staffing factors, the average number of sick days (possibly on a monthly basis and perhaps also broken down by age) could be of interest to human resource planners. Other useful data may include refresher-training days required, expected periods of annual leave, average days spent on maternal (and/or paternal) leave, average days spent on special leave.

4.6 Maintaining Skill Currency

4.6.1 Human resource planners need to know who among their staff run the risk of losing their license (or ratings) due to regulations, and who needs to revalidate their rating after spending a period of time in other duties outside the operations room. For example, controllers who already had a rating at an area control centre (ACC) and worked for a period at an aerodrome may need to undergo some form of validation exercise before returning to the ACC.

4.6.2 Operational rules could include not only the minimum period of time needed in order to maintain a valid rating, but also concerning the traffic characteristics and work circumstances (e.g. working at night).

4.7 Non ATC operational and technical staff

4.7.1 While it may not be a requirement that personnel other than ATC within the Air Traffic Service to have any form of licensing or rating, it is just as important that non-licensed personnel remain current in the skills required to carry out their main tasks. Therefore, human resource planners need to maintain a record keeping system (for example a database) that identifies all personnel and their working activities. When staff is required to be absent from their working environment for any lengthy period of time, some form of training programme should be established to address these situations.

5. STAFFING ATS FACILITIES – OPERATIONAL REQUIREMENTS

5.1 Staffing Controller Working Positions

5.1.1 In staffing controller working positions, some basic questions are:

- How many hours do positions need to be operated?
- Do the positions need to be manned by a single air traffic controller?
- Does the position also require a Data Controller/Planner?

5.1.2 During night duty, with significantly less traffic in a given sector, a controller can sometimes work alone. Depending on traffic load or the need for high levels of co-ordination with adjacent sectors or centres, a planner and/or assistant controller may be necessary. Additionally, flight information service (FIS) personnel and flight data assistants may also be an integral part of the staffing requirements for air traffic services and will need to be considered.

5.1.3 A detailed analysis for ATS staffing is carried in Chapter 8, Case Study

6. STAFFING FOR TECHNICAL SUPPORT ORGANIZATIONS

6.1 Operation and Maintenance of Facilities

6.1.1 The provision of complex equipment to support air navigation services requires large capital investments. These investments also require a parallel investment in highly qualified human resources. The size of this workforce can only be determined by making an accurate and realistic analysis of the existing situation and forecasting the requirements for staffing levels and training.

6.1.2 The organization should also define the maintenance levels to be performed at a station (site of facility) and at a centralized maintenance depot or possibly out of country maintenance. For example, each organization needs to determine if repairs at a station will be made at the module level only, or if repairs can be made down to the component level.

6.2 Equipment Inventory

6.2.1 An inventory of operational equipment should contain details of equipment types, quantities, and installation/commissioning dates and operation status. Figure 7 shows a sample from a worksheet that identifies the equipment inventory of a CNS Division. Figure 8 illustrates the requirements for preventative maintenance of the equipment inventory.

	B	C	D	E	F	G	H	I	J
2	CNS MAINTENANCE DIVISION								
3	OPERATIONAL EQUIPMENT INVENTORY								
4	ID Number	EQUIPMENT	INT. Airport Alpha (1)	INT. Airport Beta (1)	ACC En-route	Domestic Airport Grade I (4)	Domestic Airport Grade II (6)	Repair and Overhaul + TRAIIIING	Quantity
5	Enter data into Block D7...I19. Press [Tab] or [Shift] [Tab] to move betweeen fields. Use File | Save As to save your work using a new file name and dsave in the appropriate folder.								
6	1.0	Communication Equipment							
7	1.01	HF Transmitters			6				6
8	1.02	VHF Transmitters	8	8	10	24	24	2	76
9	1.03	HF Receivers			6				6
10	1.04	VHF Receivers	8	8	10	24	24	2	76
11	1.05	HF Transceivers			4				4
12	1.06	VHF Transceivers	5	5	8	16	18	2	54
13	1.07	VHF Hand-held Transceivers	10	10				4	24
14	1.08	HF Antenna System			1				1
15	1.09	VHF Remote Control Air/Ground	0	0	5	0	0		5
16	1.10	Microwave Radio Link System	2	1	2				5
17	1.11	VSAT Satellite Station	1	1	3				5
18	2.0	Message Switching Centre							
19	2.01	AFTN Automatic Switch	1	1	1				3
20	2.02	Concentrator/Terminal Equipment				4	6	2	12

WS-3 (Inv) / WS-4 (PM) / WS-5 (CM) / WS-6 (PMT) / WS-7 (CMT) / WS-8 (Mntc.WL) / WS-9

Figure 7 – Sample of CNS Equipment Inventory

	B	C	D	E	F	G	H	I
2	CNS MAINTENANCE DIVISION							
3	PREVENTATIVE MAINTENANCE DATA							
4	ID Number	EQUIPMENT	Daily PM (Hours x 365)	Weekly PM (Hours x 52)	Monthly PM (Hours x 12)	Annual PM (Hours x 1)	Unit-totals Yearly PM (Hours)	Total Yearly PM (Hours)
5	Enter data into Block D11...G54 (daily, weekly, monthly and annual preventative maintenance). Press [Tab] or [Shift] [Tab] to move betweeen fields. Use File | Save As to save your work using a new file name and save in the appropriate folder.							
6	1.0	Communication Equipment						
7	1.01	HF Transmitter	0	0.5	1	2	40	
8	1.02	VHF Transmitter	0	0.5	1	2	40	
9	1.03	HF Receivers	0	0.5	1	2	40	
10	1.04	VHF Receiver	0	0.5	1	2	40	
11	1.05	HF Transceiver	0	0.5	1	2	40	
12	1.06	VHF Transceiver	0	0.5	1	2	40	
13	1.07	VHF Hand-held Transceivers	0	0.5	0.5	1	33	
14	1.08	HF Antenna System	0	0.5	0	4	30	
15	1.09	VHF Antenna System	0	0.5	0	4	30	
16	1.10	Microwave Radio Link System	0.5	1	2	6	264.5	
17	1.11	VSAT Satellite Station	0.5	1	2	6	264.5	
18		Total Comm.						862

Figure 8 – Sample of CNS equipment preventative maintenance requirements

6.2.2 It should be noted, that all figures used in Figures 7 and 8 are hypothetical and do not relate to any actual CNS organization.

6.3 Task-Load Factor

> A facility "*task-load*" factor is the yearly total maintenance requirements expressed in hours for each facility

6.3.1 A yearly "*task –load"* factor for each facility or equipment type should be determined, based upon the maintenance levels for each facility. Calculations need to be carried out on each facility or equipment type to determine the work-hours per year to perform all the maintenance tasks. For example an ILS comprising a localizer, glidescope and marker beacons may require a total of 1000 hours per year to complete all the maintenance tasks

6.3.2 Once all the individual equipment calculations have been completed, the sum total for the maintenance tasks is totalled. In addition to hours allocated for periodic maintenance, an assessment of other activities such as corrective maintenance times, travel time to/from facility locations and flight calibration (if ground support is required) for all equipment is established. Technical activities outside the scope of maintenance such as, modifications, installation or assisting with the preparatory work should be included in the allotment by an additional allowance of approximately 10% of the total maintenance work-hours for the facility concerned. The total yearly hours obtained from combined task-load factors may be compared with any statistical data derived from a fault reporting system and daily site/facility records. The task-load factors may then be adjusted accordingly to proven statistical data.

6.4 Human Resource Qualifications to Support the Maintenance Philosophy

6.4.1 Once all the above is established, the organization should then define the technical qualifications required to fulfil each level of maintenance. It is beyond the scope of this manual to define or even suggest the maintenance philosophy that should be adopted by a CNS maintenance organization. However, for the purpose of illustration, Figure 9 provides an example of an approach that identifies specific maintenance levels that may be in use by organizations.

6.4.2 Today's integrated remote control and monitoring systems (RCMS) are highly sophisticated tools that provide a simple, intuitive and consistent interface to the broad range of equipment used at an airport or for en-route facilities. They are used in order to maximize availability of air navigation systems by enabling a remote user to identify fault conditions quickly, to reconfigure equipment and restore the operational service, and to minimize repair times by providing remote and efficient fault diagnosis. The RCMS can also be used to indirectly analyze long-term equipment performance and availability, to identify equipment and services that have high failure rates and also to act as a visual training aid for engineering personnel.

Maintenance Levels

Maintenance Level 1
Involves periodic preventative maintenance including, daily, weekly and monthly maintenance, which includes cleaning, meter readings and equipment checks, carried out by on-site technicians.

Maintenance Level 2
Is conducted on an as required basis, It is corrective maintenance which includes replacement of modules and preparation of technical services for flight calibration. On-site technicians who have been trained on the specific equipment carry out trouble shooting diagnostics.

Maintenance Level 3
Is classified as corrective maintenance (repair) and is conducted when a malfunction occurs which could not be rectified by a Maintenance Level 2 technician. A technician sent from a central maintenance facility may conduct the work.

Maintenance Level 4
Is classified as corrective maintenance, mainly by component replacements. This type of maintenance or repair needs special tools, measuring instruments and test benches only available at specially equipped Repair and Overhaul facilities, frequently this is performed by a commercial enterprise or the original manufacturer.

Remote Diagnostic Monitoring and Maintenance - Level 5
This is a category that is becoming more prevalent in the maintenance of air traffic management systems. As communications infrastructure is improved to enable the use of data communication, Remote Control and Monitoring System (RCMS) is becoming an essential tool in the continued drive to greater efficiency while ensuring that the high levels of operational service are also maintained.

Figure 9 Sample maintenance levels that may be in use by organizations.

6.5 Determining Staffing Requirements for CNS Organization

6.5.1 A typical approach to determine staffing requirement for electronic systems maintenance would be as follows:

Checklist of activities for support of CNS human resource planning

1. For each equipment determine the maintenance activities
2. For each maintenance activity determine the measurable elements, for example:
   - Check equipment maintenance log book
   - Check operations log book
   - Read remote monitor status indications
   - Record status indications in equipment log book
   - At equipment site:
     - ✓ Read equipment room temperature
     - ✓ Record temperature in equipment log book
     - ✓ Perform daily maintenance checks as per checklist.
     - ✓ Record daily check results in equipment log book

   Continue determining the measurable elements for each maintenance activity.

3. Determine related activities, such as, completing requests for spare-parts, obtaining transport, travel to remote sites, etc.
4. Observe technicians doing each activity element and record the time taken to complete each one. This data can also be determined by reviewing the time required for each activity in the facility logbook.
5. Determine total maintenance time for each item of equipment.
6. Determine the time taken to perform unrelated activities.
7. Calculate total technician activity time for each category. Because of the size and complexity of some ATS units not all technicians may be qualified to work on all equipment. For example, some states will have navaid technicians, radar technicians, communication technicians and data processing/display technicians. Other states will combine the maintenance of radar and data processing/display for one group of technicians.
8. Apply the staffing factor to determine staffing needs, illustrated in Appendix B and Chapter 8, Case Study.

Figure 10 Checklist of activities for support of CNS human resource planning

6.5.2 The aim of the human resource planner is to determine the number of technical staff required to support the organizations maintenance philosophy which in turn is an integral function of the air traffic service. Naturally, the minimum number of staff to provide this service is the most economical. However this is invariably not achievable due to factors such as, safety, on-the-job training requirements (for junior staff), time delays due to locations of facilities.

6.5.3 In practice, a staffing figure of somewhere between the minimum as determined by a simple method such as the staffing factor calculation, and a figure that calculates the “task-load staff requirements” by using the “staffing factor” with the “task-load factor” (see Appendix B). The human resource planner needs to remain current with CNS planning, as changes in facilities with introduction of new technologies will invariably require adjustments to staffing figures.

7 SUMMARY

7.1 Staffing for Air Traffic Control

7.1.1 Air traffic control is an extremely dynamic enterprise. Traffic conditions can change hourly, weather is unpredictable, and local traffic can be affected by the "domino effect". What happens on the other side of the world can eventually be felt in the local FIR. Thus planning for minimum or staffing figures to support operational requirements can be a daunting task. The experience of the local supervisors in this area is invaluable and the person's responsible for the human resource planning must maintain a close contact with them.

7.2 CNS Maintenance

7.2.1 The CNS maintenance division is responsible for a large and varied inventory of sophisticated communications, navigation and surveillance equipments. As all these facilities tend to be static in nature, it is relatively easy to determine the staffing requirements to support their satisfactory operation. However, due to the high reliability of many of these systems, it is getting more difficult to prepare a good human resource-staffing plan that is also economical to implement. An organization cannot afford to have highly skilled staff who are relatively inactive for much of their duty periods but at the same time reliability, safety and efficiency of facilities is the paramount role for the CNS facilities.

7.2.2 Again the human resource planner needs to have a good understanding of the characteristics of the CNS facilities and the staffing needs in order for them to be maintained to the stated requirements. Close association with CNS supervisory staff is essential.

7.3 Practical Human Resource Staffing

7.3.2 In all cases, ATC, CNS Maintenance or other aeronautical sections, the human resource staffing requirement probably lies somewhere between the minimum staffing and task-load staffing calculated figures. The results offered by these guidelines, are just that, "guidelines". It is up to the local management staff, with the understanding of local conditions to make the final decision on what is the correct staffing figure.

Revised: 5/23/2003 8:09 AM

APPENDIX A
CHAPTER 2

HOW TO CALCULATE HUMAN RESOURCE NEEDS
"AIR TRAFFIC CONTROL"

1. Human Resource Analysis

1.1 Determine specific working variables

1.1.1 In order to provide sufficient staff to meet operational requirements, it is necessary to determined specific working variables. These variables include, identifying the total activity hours per year, the number of working hours in a year, and determining the number of productive hours in a workday and the number of operational days and hours required in a year. The variables would take into account periods of leave, sickness and training etc. In order to calculate the staff requirement for a particular operational/technical activity, it is necessary to obtain appropriate data regarding the local work regulations.

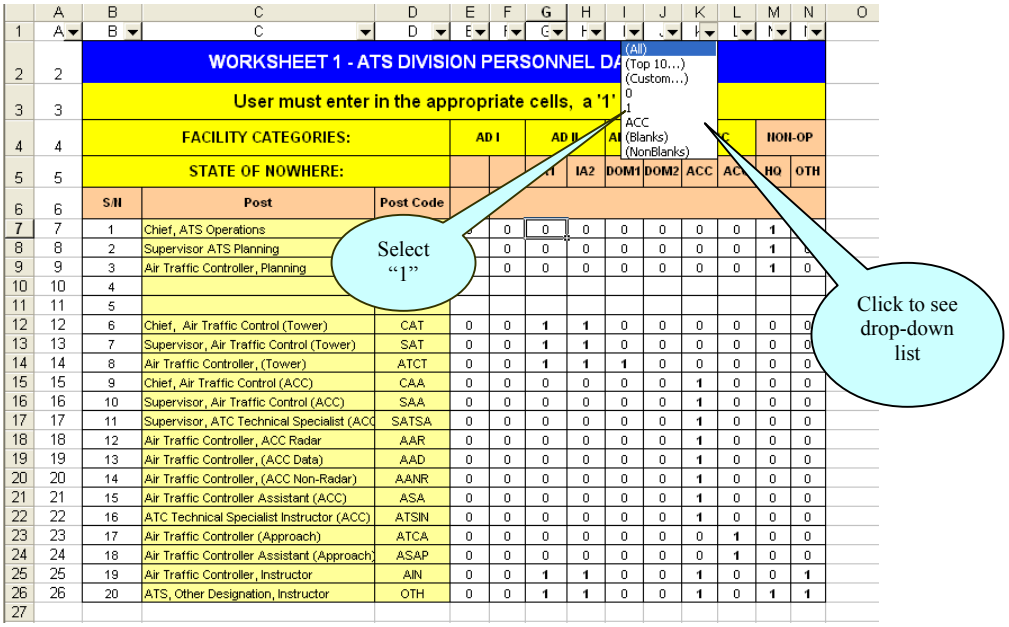
1.2 Staff Position Listing – Air Traffic Control (ATC)

1.2.1 It is preferable if a listing be produced (if not already available) of all ATC positions within the organization. This should include both operational, non-operational and management positions. It is sufficient enough for our needs to produce a simple outline of the titles and where the posts are active, i.e. headquarters, planning office, specific aerodrome control tower, and area control centre.

1.2.2 Figure 1 (*Worksheet 1*) demonstrates one such position listing. Computer spreadsheets are particularly useful when using tables to determine staffing needs *Worksheet 1* is part of a Microsoft Excel Spreadsheet workbook and it utilizes the "Data / Filter / Auto filter" mode. This enables the worksheet to act as a small database and filter out a variety of results.

1.2.3 The user of Worksheet 1, is required to enter a "1" or "0" into the appropriate cell in cell block E7…N26 (not shown in Figure 1). A "1" represent the requirement for that post in the specific location and a "0" represents no requirement for the post.

1.2.4 Figure 1 (*Worksheet 1*) shows a "*drop-down*" list for facility category "aerodrome grade II – International Airport No.1" (AD II" **–** "IA1). If Item "1" is selected then the worksheet will indicate the specific post that are required for this facility category. A useful aspect of "*worksheet 1*" is the ability of linking the worksheet data such as; *Posts* and *Post Code* to other worksheets within this and other workbooks. This action ensures the accuracy of this data in all worksheets and, reduces the amount of work if replacement of data is necessary. This approach is also used in the Chapter 8 Case Study.



S/N	Post	Post Code	AD I	AD II	IA1	IA2	DOM1	DOM2	ACC	HQ	OTH
1	Chief, ATS Operations		0	0	0	0	0	0	0	1	
2	Supervisor ATS Planning		0	0	0	0	0	0	0	1	
3	Air Traffic Controller, Planning		0	0	0	0	0	0	0	1	0
4											
5											
6	Chief, Air Traffic Control (Tower)	CAT	0	0	1	1	0	0	0	0	0
7	Supervisor, Air Traffic Control (Tower)	SAT	0	0	1	1	0	0	0	0	0
8	Air Traffic Controller, (Tower)	ATCT	0	0	1	1	1	0	0	0	0
9	Chief, Air Traffic Control (ACC)	CAA	0	0	0	0	0	0	1	0	0
10	Supervisor, Air Traffic Control (ACC)	SAA	0	0	0	0	0	0	1	0	0
11	Supervisor, ATC Technical Specialist (ACC	SATSA	0	0	0	0	0	0	1	0	0
12	Air Traffic Controller, ACC Radar	AAR	0	0	0	0	0	0	1	0	0
13	Air Traffic Controller, (ACC Data)	AAD	0	0	0	0	0	0	1	0	0
14	Air Traffic Controller, (ACC Non-Radar)	AANR	0	0	0	0	0	0	1	0	0
15	Air Traffic Controller Assistant (ACC)	ASA	0	0	0	0	0	0	1	0	0
16	ATC Technical Specialist Instructor (ACC)	ATSIN	0	0	0	0	0	0	1	0	0
17	Air Traffic Controller (Approach)	ATCA	0	0	0	0	0	0	0	1	0
18	Air Traffic Controller Assistant (Approach)	ASAP	0	0	0	0	0	0	0	1	0
19	Air Traffic Controller, Instructor	AIN	0	0	1	1	0	0	1	0	1
20	ATS, Other Designation, Instructor	OTH	0	0	1	1	0	0	1	0	1

Figure 1 (*Worksheet 1)* ATS Division, Personnel Database

Legend for Worksheet 1

AD I	***Aerodrome Grade I***
AD II	***Aerodrome Grade II***
AD III	***Aerodrome Grade III***
AD IV	***Aerodrome Grade IV***
Non-Op	***Non operational facility***
1A1	***International Airport No. 1***
1A2	***International Airport No. 2***
ACC	***Area Control Centre***
AFTN	***AFTN Message Switch Centre***
DOM1	***Domestic Aerodrome Grade 1***
DOM2	***Domestic Aerodrome Grade 2***

1.2.7 The following are explanations regarding various abbreviations in Worksheet 1:

a) **Aerodrome Grade I and II** (AD Type I and II) are on a 24-hour service basis and high-density traffic, typically equipped with precision approach radar (PAR), instrument landing system (ILS Cat I, II or III). Approach services are an ACC responsibility. Difference between Grade I and II is the volume of traffic to be managed.

b) **Aerodrome Grade III and IV** (AD" Type III and IV) are non 24-hour operation aerodromes with reduced traffic to be managed. Typically navigation facilities for these aerodromes are VOR/DME, precision approach lighting or non-precision

approach lighting. Non-directional beacons (NDB's) are still common in many States.

c) **Area Control Centre - Radar** (ACC*)* are radar equipped, multiple sector to be controlled and with Oceanic Control. Simulator is in place for air traffic controller rating training. En-route navigation aids include VOR/DME

d) Area Control Centre – Non-Radar. This is a procedural control facility only.

1.3 Staffing Data Worksheet Input Data

1.3.1 The next step is to gather the relevant information, confirm its accuracy and input the data into the ATS Staffing Input Data Worksheet, *Worksheet 2* (Figure 2). The data after entry will automatically be transferred into the ATS Facility – *Staffing Calculation Worksheet, Worksheet 3* (Figure 3).

1.4 The *Staff Work Unit*

1.4.1 The first prime data that is determined by *worksheet 3* is the "*staff work unit"* which is defined as the available working hours per year for one staff member (in this case an Air Traffic Controller). A *staff work unit* is considered as one person who is capable of ¨x¨ number of hours of productive effort per year. This figure is derived from the "*effective hours per day*" that can be worked, and the "available work days per year".

1.5 The Minimum Staff Requirement – "*Operational Staffing Factor"*

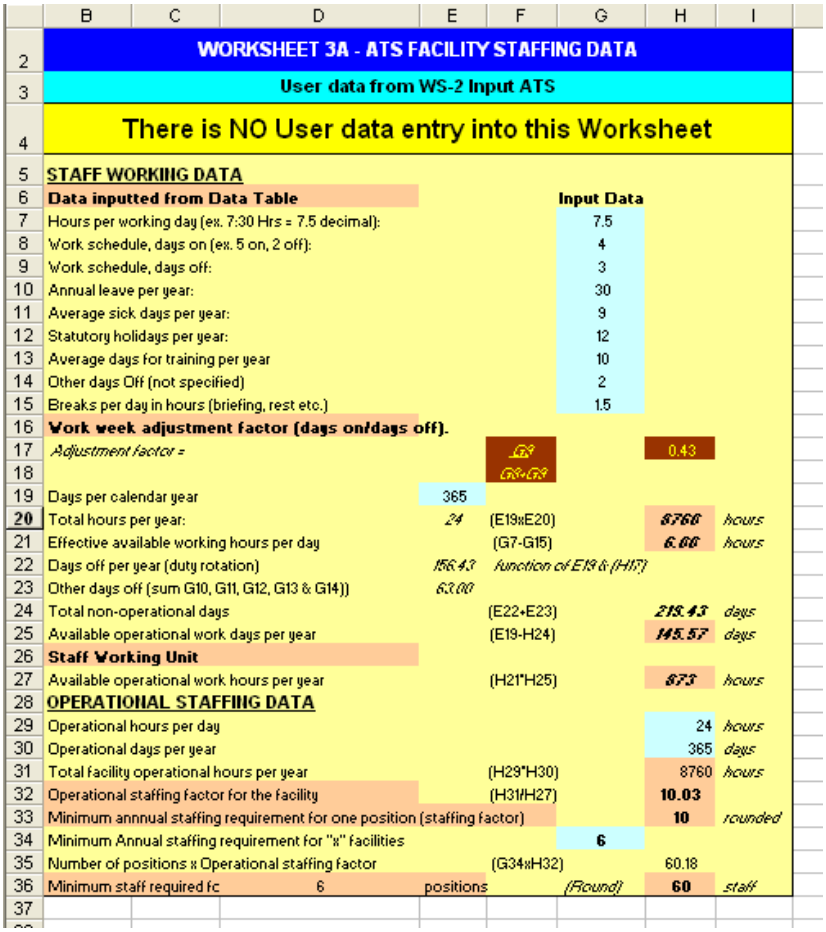
1.5.1 The "*operational staffing factor"* is a method used to determine the *minimum* number of staff required to support a specific operational requirement. It is a mathematical equation, which uses the determined "*staff work unit"* and the total number of working hours in one year. The calculations illustrated in "*Worksheet 3"* provide a method of deriving an "*operational staffing factor"*. It is emphasised, that the "*operational staffing factor"* will provide a figure only for the minimum number of staff required for a specific function/facility (for example an air traffic control position or navigation aid facility) without taking into account other factors such as rostering, safety margins and on-the-job training.

	B	C	D
2	**WORKSHEET 2 - ATS STAFFING/OPERATIONAL INPUT DATA**		
3	**Enter data into Column 'C'. Press [TAB] or [Shift] [Tab] to move between fields. Use File / Save As, to save your work using a new file name. Save in an appropriate Folder.**		
4	**Description of Data**	**User Data Input**	
5	**PERSONNEL DATA**		
6	**Days per year:**	365	
7	**Hours per working day:**	7.5	
8	**Work schedule, Days On:**	4	
9	**Work schedule, Days Off:**	3	
10	**Annual leave, Days per year:**	30	
11	**Average sick days per year:**	9	
12	**Statutory holidays per year:**	12	
13	**Average training days per year:**	10	
14	**Other (days off per year):**	2	
15	**Breaks per working day (in Hours):**	1.5	
16	**OPERATIONAL DATA**		
17	**No. of work positions to be covered:**	6	
18	**Operation days per year:**	365	
19	**Operation hours/day:**	24	
20			

Figure 2 Staff data input sheet for ATC (*Worksheet 2*)

Note:

The data shown in Figure 2 are samples only and do not represent any specific working environment.



	B	C	D	E	F	G	H	I
2	**WORKSHEET 3A - ATS FACILITY STAFFING DATA**							
3	**User data from WS-2 Input ATS**							
4	**There is NO User data entry into this Worksheet**							
5	**STAFF WORKING DATA**							
6	**Data inputted from Data Table**					**Input Data**		
7	Hours per working day (ex. 7:30 Hrs = 7.5 decimal):					7.5		
8	Work schedule, days on (ex. 5 on, 2 off):					4		
9	Work schedule, days off:					3		
10	Annual leave per year:					30		
11	Average sick days per year:					9		
12	Statutory holidays per year:					12		
13	Average days for training per year					10		
14	Other days Off (not specified)					2		
15	Breaks per day in hours (briefing, rest etc.)					1.5		
16	**Work week adjustment factor (days on/days off).**							
17	*Adjustment factor =*				*G9 / (G9+G9)*		0.43	
18								
19	Days per calendar year			365				
20	Total hours per year:			*24*	(E19*E20)		*8760*	*hours*
21	Effective available working hours per day				(G7-G15)		*6.00*	*hours*
22	Days off per year (duty rotation)			*156.43*	*function of E19 & (H17)*			
23	Other days off (sum G10, G11, G12, G13 & G14))			*63.00*				
24	Total non-operational days				(E22+E23)		*219.43*	*days*
25	Available operational work days per year				(E19-H24)		*145.57*	*days*
26	**Staff Working Unit**							
27	Available operational work hours per year				(H21*H25)		*873*	*hours*
28	**OPERATIONAL STAFFING DATA**							
29	Operational hours per day						24	*hours*
30	Operational days per year						365	*days*
31	Total facility operational hours per year				(H29*H30)		8760	*hours*
32	Operational staffing factor for the facility				(H31/H27)		**10.03**	
33	Minimum annnual staffing requirement for one position (staffing factor)						**10**	*rounded*
34	Minimum Annual staffing requirement for "x" facilities					**6**		
35	Number of positions x Operational staffing factor				(G34xH32)		60.18	
36	Minimum staff required fc		6	positions		*(Round)*	**60**	*staff*
37								

Figure 3 Determining Working Unit and Staffing Factors (*Worksheet 3*)

1.6 Data from Worksheet 3 (Figure 3)

a) Working Unit (effective working hours per year per person) **873** hours
b) **Staffing Factor** (total hours per year/effective hours per year) **10.03**
c) **Minimum** staff required for one or multi working positions

2. Determining Staffing for ATS Sectors

2.1 Occupation time of the positions in any given sector

2.1.1 The basis of human resource planning (on a sector level) is the occupation time of the positions in any given sector based on the opening and closing time of the positions. These times are derived from the amount of traffic to be processed in that sector, which are identified as the operational requirements.

2.1.2 The data shown in Figures 4 and 5 (*Worksheets 4 and 5*) is based on a two sector (west and east) area control centre (ACC). The west sector is non-radar while the east-sector is radar controlled. Air traffic controllers staff the positions as required to meet the operational requirements of the sectors and appropriate work timetable is used for staff working hours.

2.1.3 The first step in the ATC staff requirement analysis is to identify all the categories of staff that will be required to operate the ACC facilities. This information is extracted from *Worksheet 1* (Figure 1) ATC Division Personnel Database.

2.1.4 The following job categories and their abbreviations are used from *Worksheet 1*.

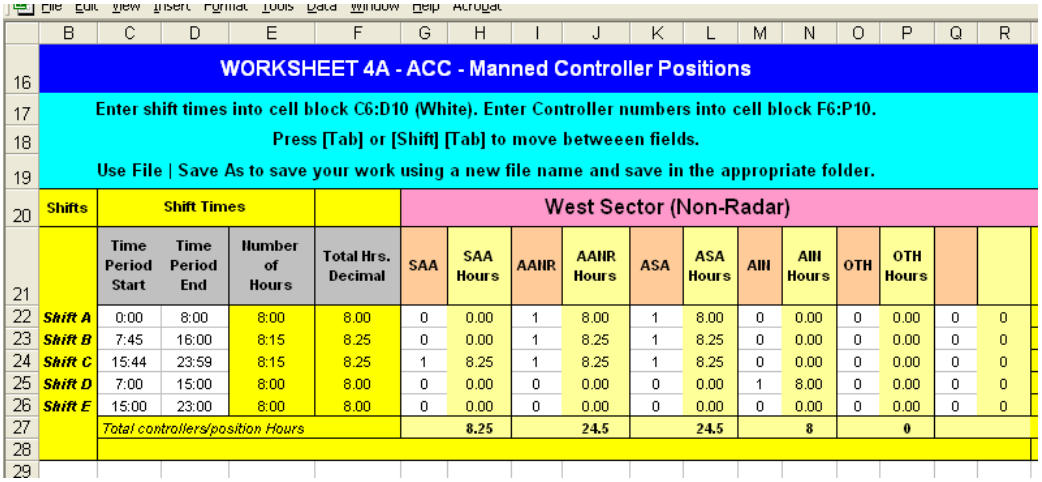
Data from: Worksheet 1 (WS-1) ATS Division Personnel Database

Code	Category Title
CAA	Chief, Air Traffic Control (ACC)
SAA	Supervisor, Air Traffic Control (ACC)
SATSA	Supervisor, ATC Technical Specialist (ACC)
AAR	Air Traffic Controller, ACC Radar
AAD	Air Traffic Controller, (ACC Data)
AANR	Air Traffic Controller, (ACC Non-Radar)
ASA	Air Traffic Controller Assistant (ACC)
ATSIN	ATC Technical Specialist Instructor (ACC)
AIN	Air Traffic Controller, Instructor

Table 1 ACC staff categories

2.2 Worksheet for ACC Staffing

2.2.1 Figure 4 (*Worksheet 4A*) is the data analysis worksheet for the ATC West Sector Area Control Centre (ACC). Figure 5 (*Worksheet 4B*) is the data analysis worksheet for the ATC East Sector Area Control Centre (ACC).



WORKSHEET 4A - ACC - Manned Controller Positions

Enter shift times into cell block C6:D10 (White). Enter Controller numbers into cell block F6:P10.
Press [Tab] or [Shift] [Tab] to move betweeen fields.
Use File | Save As to save your work using a new file name and save in the appropriate folder.

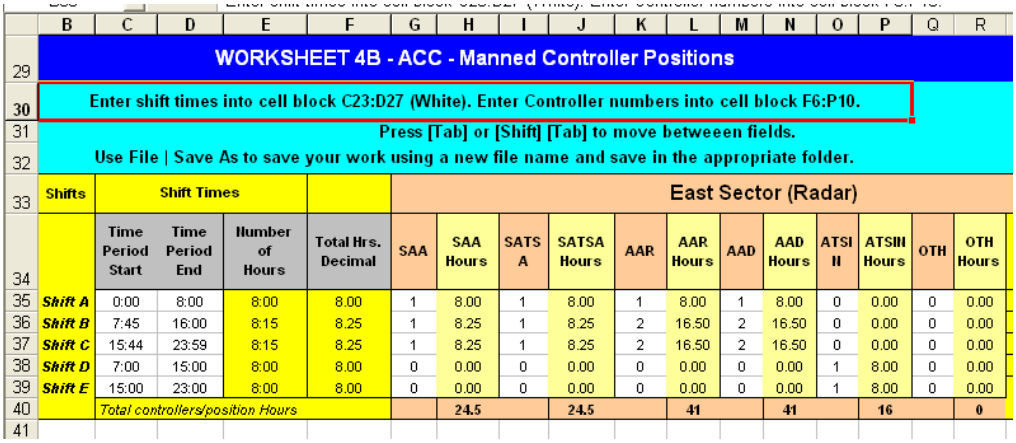
Shifts	Shift Times				West Sector (Non-Radar)											
	Time Period Start	Time Period End	Number of Hours	Total Hrs. Decimal	SAA	SAA Hours	AANR	AANR Hours	ASA	ASA Hours	AIN	AIN Hours	OTH	OTH Hours		
Shift A	0:00	8:00	8:00	8.00	0	0.00	1	8.00	1	8.00	0	0.00	0	0.00	0	0
Shift B	7:45	16:00	8:15	8.25	0	0.00	1	8.25	1	8.25	0	0.00	0	0.00	0	0
Shift C	15:44	23:59	8:15	8.25	1	8.25	1	8.25	1	8.25	0	0.00	0	0.00	0	0
Shift D	7:00	15:00	8:00	8.00	0	0.00	0	0.00	0	0.00	1	8.00	0	0.00	0	0
Shift E	15:00	23:00	8:00	8.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0
	Total controllers/position Hours					8.25		24.5		24.5		8		0		

Figure 4 (*Worksheet 4A*) West Sector Shift Times and Staffing Requirements

2.2.2 The user is required to enter the appropriate information into the following cell-blocks of Figure 4 (*Worksheet 4A, West sector shift times and staffing requirements*).

- C21…D25, shift times for shifts A, B, C, D and E hours
- G21…G25, SAA requirements for each shift
- I21…I25, AANR requirements for each shift
- K21…K25, ASA requirements for each shift
- M21…M25, AIN requirements for each shift
- O21…O25, OTH requirements for each shift

All other data in Worksheet 4A, will be automatically computed.



WORKSHEET 4B - ACC - Manned Controller Positions

Enter shift times into cell block C23:D27 (White). Enter Controller numbers into cell block F6:P10.
Press [Tab] or [Shift] [Tab] to move betweeen fields.
Use File | Save As to save your work using a new file name and save in the appropriate folder.

Shifts	Shift Times				East Sector (Radar)											
	Time Period Start	Time Period End	Number of Hours	Total Hrs. Decimal	SAA	SAA Hours	SATS A	SATSA Hours	AAR	AAR Hours	AAD	AAD Hours	ATSI II	ATSIII Hours	OTH	OTH Hours
Shift A	0:00	8:00	8:00	8.00	1	8.00	1	8.00	1	8.00	1	8.00	0	0.00	0	0.00
Shift B	7:45	16:00	8:15	8.25	1	8.25	1	8.25	2	16.50	2	16.50	0	0.00	0	0.00
Shift C	15:44	23:59	8:15	8.25	1	8.25	1	8.25	2	16.50	2	16.50	0	0.00	0	0.00
Shift D	7:00	15:00	8:00	8.00	0	0.00	0	0.00	0	0.00	0	0.00	1	8.00	0	0.00
Shift E	15:00	23:00	8:00	8.00	0	0.00	0	0.00	0	0.00	0	0.00	1	8.00	0	0.00
	Total controllers/position Hours					24.5		24.5		41		41		16		0

Figure 5 (*Worksheet 4B*) East Sector Shift Times and Staffing Requirements

2.2.3 The user is required to enter the appropriate information into the following cell-blocks of Figure 5 (*Worksheet 4B, East sector shift times and staffing requirements*).

- C35…D39, shift times for shifts A, B, C, D and E hours
- G35…G39, SAA requirements for each shift
- I35…I39, SATSA requirements for each shift
- K35…K39, AAR requirements for each shift
- M35…M39, AAD requirements for each shift
- O35…O39, ATSIN requirements for each shift
- Q35…Q39, OTH requirements for each shift

All other data in Worksheet 4B, is automatically computed.

2.2.4 The process outlined in paragraphs 2.2.2 and 2.2.3 are also illustrated in Chapter 8, Case Study. Both worksheets 4A and 4B accommodate sufficient blank rows so the user can enter different shift times from those illustrated.

2.2.5 From an analysis of Figure 4 (Worksheet 4A) and Figure 5 (Worksheet 4B) we obtain the number of controllers required to staff all positions during the 24 hour operational period. The requirements to fill a position during a specific shift-period are determined by the operational requirements. The operational manager/supervisor will provide these figures and may adjust them time from time if there are any special factors to be considered.

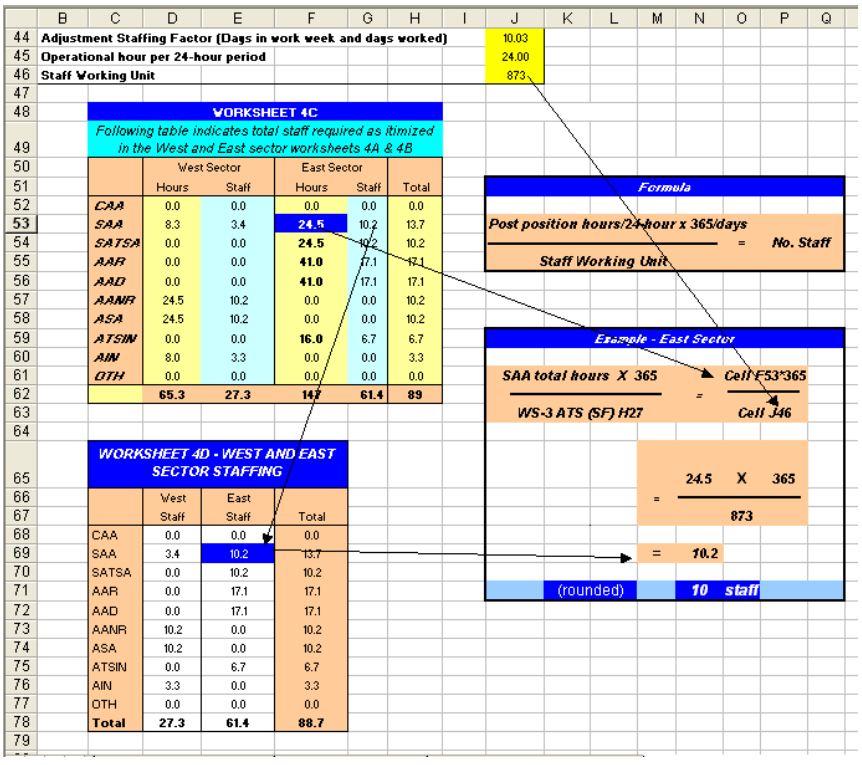


Figure 6 (*Worksheets 4C and 4D*) Total staff to support west and east sectors

2.2.6 Figure 6 (*Worksheets 4C and 4D*) indicates the total number of staff required for each job category to cover the shift periods indicated in *Worksheet 4A and 4B*. It can be seen that the total number of staff required is 89 (*Worksheet 4D*). The *formula* and *example* show the method of calculating for number of staff required for one post. In this case the *Supervisor, Air Traffic Control, ACC East Sector (SAA)*. The inputs to the formula are, *total hours of SAA*, the *staff working unit* (from *Worksheet 3*) and *365 days per year*. The result with the parameters inputted into Worksheet 2, is *10 staff* to cover the 24-hour shift period for 365 days a year.

2.3 Variation between minimum staffing and optimum staffing to meet the operational requirements

2.3.1 Figure 3 (*Worksheet 3*), ATS Facility Staffing Data produces an "*operation staffing factor*" of 10.03 which in turn provides a minimum staffing figure for six-positions of 60. The figure "60" however can be misleading in this particular scenario. The figures in Worksheet 3, assume all six positions operate for the full 24-hour period. Whereas, Figures 4 and 5 (Worksheet 4A and 4B) provide different staffing for different periods, based on sector opening and closing times.

Revised: 5/23/2003 9:09 AM

APPENDIX B
Chapter 2

HOW TO CALCULATE HUMAN RESOURCE NEEDS FOR CNS MAINTENANCE FACILITIES

1. Human Resource Analysis

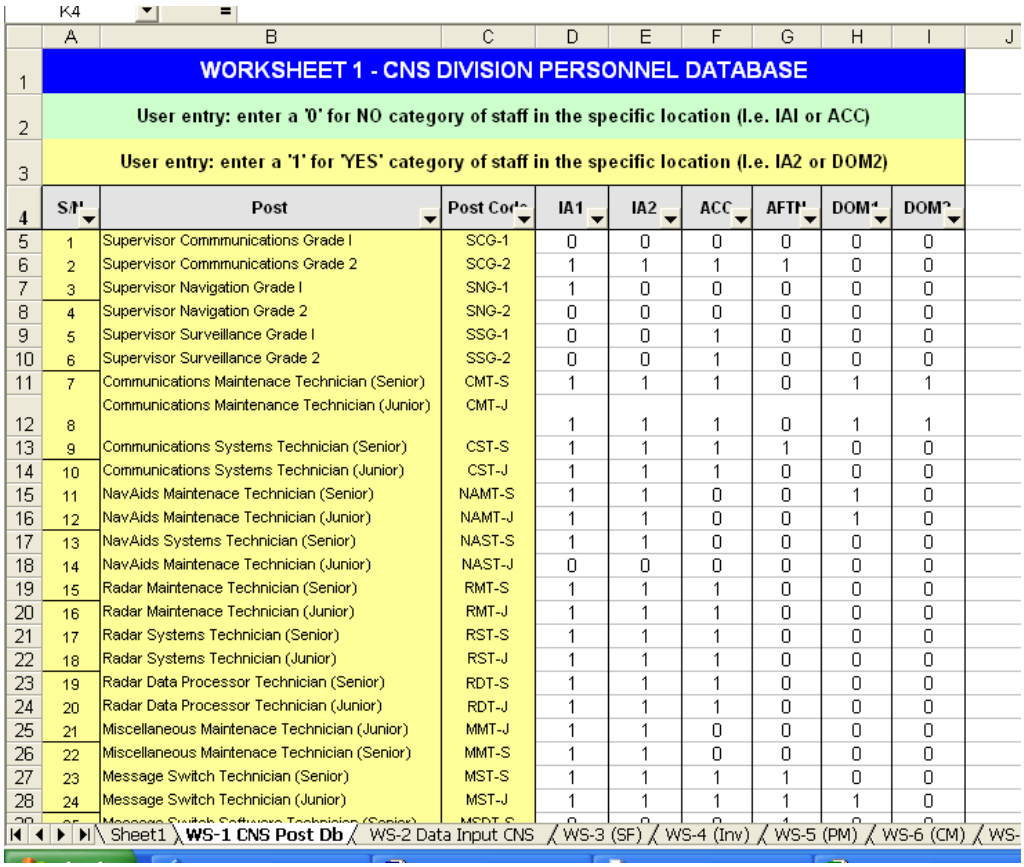
1.1 Staff Position Listing – CNS Maintenance Facilities

1.1.1 As mentioned in Appendix A for ATC, it is preferable if a listing be produced (if not already available) of all CNS positions within the organization. This should include both operational, non-operational and management positions. It is sufficient enough for our needs to produce a simple outline of the titles and where the posts are active, i.e. headquarters, planning office, specific aerodrome control tower, and area control centre.

1.1.2 Figure 1 (*Worksheet 1*) illustrates one such position listing. Computer spreadsheets are particularly useful when using tables to determine staffing needs *Worksheet 1* is part of a Microsoft Excel Spreadsheet workbook and it utilizes the "Data / Filter / Auto filter" mode. This enables the worksheet to act as a small database and filter out a variety of results.

1.1.3 The user of *Worksheet 1*, is required to enter a "1" or "0" into the appropriate cell in cell block D5…I34 (not shown in Figure 1). A "1" represents the requirement for that post in the specific location and a "0" represents no requirement for the post.

1.1.4 Figure 1 (Worksheet 1) shows a "*drop-down*" list for facility category International Airport No.1 (IA1). If Item "1" is selected then the worksheet will indicate the specific posts that are required for this facility category. A useful aspect of "*worksheet 1*" is the ability of linking the worksheet data such as; *Posts* and *Post Code* to other worksheets within this and other workbooks. This action ensures the accuracy of this data in all worksheets and reduces the amount of work if replacement of data is necessary.



	A	B	C	D	E	F	G	H	I	J
1	WORKSHEET 1 - CNS DIVISION PERSONNEL DATABASE									
2	User entry: enter a '0' for NO category of staff in the specific location (I.e. IAI or ACC)									
3	User entry: enter a '1' for 'YES' category of staff in the specific location (I.e. IA2 or DOM2)									
4	S/N	Post	Post Code	IA1	IA2	ACC	AFTN	DOM1	DOM2	
5	1	Supervisor Commmunications Grade I	SCG-1	0	0	0	0	0	0	
6	2	Supervisor Commmunications Grade 2	SCG-2	1	1	1	1	0	0	
7	3	Supervisor Navigation Grade I	SNG-1	1	0	0	0	0	0	
8	4	Supervisor Navigation Grade 2	SNG-2	0	0	0	0	0	0	
9	5	Supervisor Surveillance Grade I	SSG-1	0	0	1	0	0	0	
10	6	Supervisor Surveillance Grade 2	SSG-2	0	0	1	0	0	0	
11	7	Communications Maintenace Technician (Senior)	CMT-S	1	1	1	0	1	1	
12	8	Communications Maintenance Technician (Junior)	CMT-J	1	1	1	0	1	1	
13	9	Communications Systems Technician (Senior)	CST-S	1	1	1	1	0	0	
14	10	Communications Systems Technician (Junior)	CST-J	1	1	1	0	0	0	
15	11	NavAids Maintenace Technician (Senior)	NAMT-S	1	1	0	0	1	0	
16	12	NavAids Maintenace Technician (Junior)	NAMT-J	1	1	0	0	1	0	
17	13	NavAids Systems Technician (Senior)	NAST-S	1	1	0	0	0	0	
18	14	NavAids Maintenace Technician (Junior)	NAST-J	0	0	0	0	0	0	
19	15	Radar Maintenace Technician (Senior)	RMT-S	1	1	1	0	0	0	
20	16	Radar Maintenace Technician (Junior)	RMT-J	1	1	1	0	0	0	
21	17	Radar Systems Technician (Senior)	RST-S	1	1	1	0	0	0	
22	18	Radar Systems Technician (Junior)	RST-J	1	1	1	0	0	0	
23	19	Radar Data Processor Technician (Senior)	RDT-S	1	1	1	0	0	0	
24	20	Radar Data Processor Technician (Junior)	RDT-J	1	1	1	0	0	0	
25	21	Miscellaneous Maintenace Technician (Junior)	MMT-J	1	1	0	0	0	0	
26	22	Miscellaneous Maintenace Technician (Senior)	MMT-S	1	1	0	0	0	0	
27	23	Message Switch Technician (Senior)	MST-S	1	1	1	1	0	0	
28	24	Message Switch Technician (Junior)	MST-J	1	1	1	1	1	0	

Sheet1 | WS-1 CNS Post Db | WS-2 Data Input CNS | WS-3 (SF) | WS-4 (Inv) | WS-5 (PM) | WS-6 (CM) | WS-

Figure 1 (*Worksheet 1*) CNS Staffing Positions

1.2 Determine Specific Local Working Factors

1.2.1 To provide sufficient numbers of staff to meet operational requirements, it is first necessary to determined specific local working factors. These factors include, identifying the total activity hours per year, the number of working hours in a year, and determining the number of productive hours in a workday. These factors would take into account periods of absence from the normal place of duty such as, leave and training.

1.2.2 The calculations illustrated in *Worksheet 3*, indicate a method of deriving a "*operational staffing factor*" used to determine CNS staff required for the maintenance support ATS activities.

1.3 The Staff Working Unit

1.3.1 The *"staff working unit"* is defined as the average working hours per year for one staff member (in this case a CNS maintenance technician). A working unit is considered as one person who is capable of ¨x¨ number of hours of productive effort per year.

1.4. Staffing Needs

1.4.1 Obtaining the *staff working unit* and in turn the *operational staffing factor* will provide a simple means of determining the staffing require to support the maintenance of a single facility. For example, the staff required to provide 24-hour coverage of a VOR/DME facility. This would assume that each staff member is fully qualified for the function. This approach can be useful for small units where detailed inventory data and complex rostering are not major factors.

1.4.2 For an effective staffing indication to meet full maintenance requirements of multiple facilities, it is necessary to obtain the data regarding all the CNS maintenance needs of the organization. With this information along with personnel data plus any roster calculations, overall staffing requirements for efficient operation of technical services can be obtained.

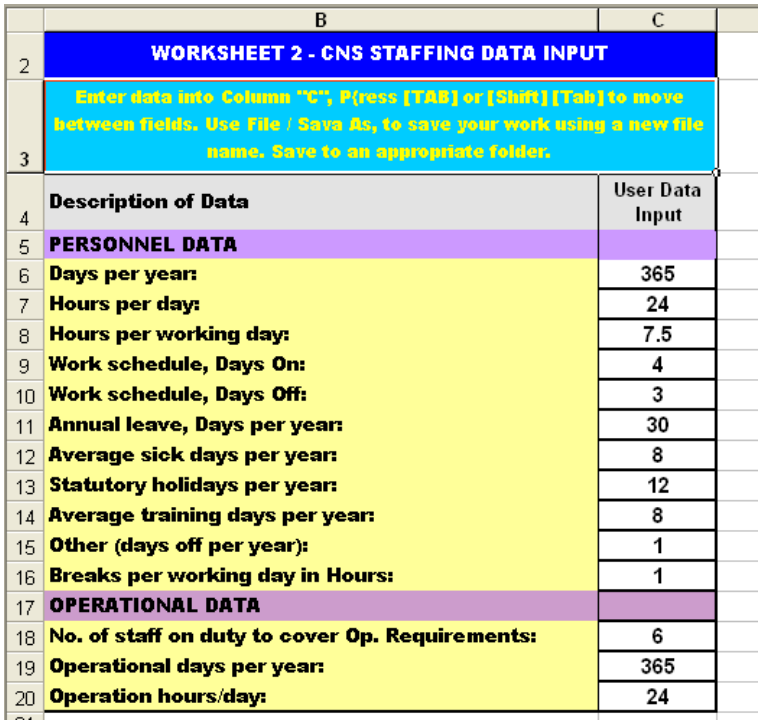
1.4.3 The following sections outline an approach used to determine CNS Maintenance staffing requirements.

2. STAFFING METHODOLOGIES

2.1 "Staff Working Unit" and "Operational Staffing Factor" Calculation

2.1.1 The first step in the human resource planning process for a particular operational requirement is to determine certain basic facts regarding conditions of service of the individuals concerned. Figure 2 (*Worksheet 2*) is used to enter the required data to determine the elements associated with the "Staffing and the "Working Unit".

2.1.2 The personnel data and operational (hours) requirements are entered into an appropriate CNS data input worksheet. Figure 2, (*Worksheet 2)* is a completed sample of such a worksheet.

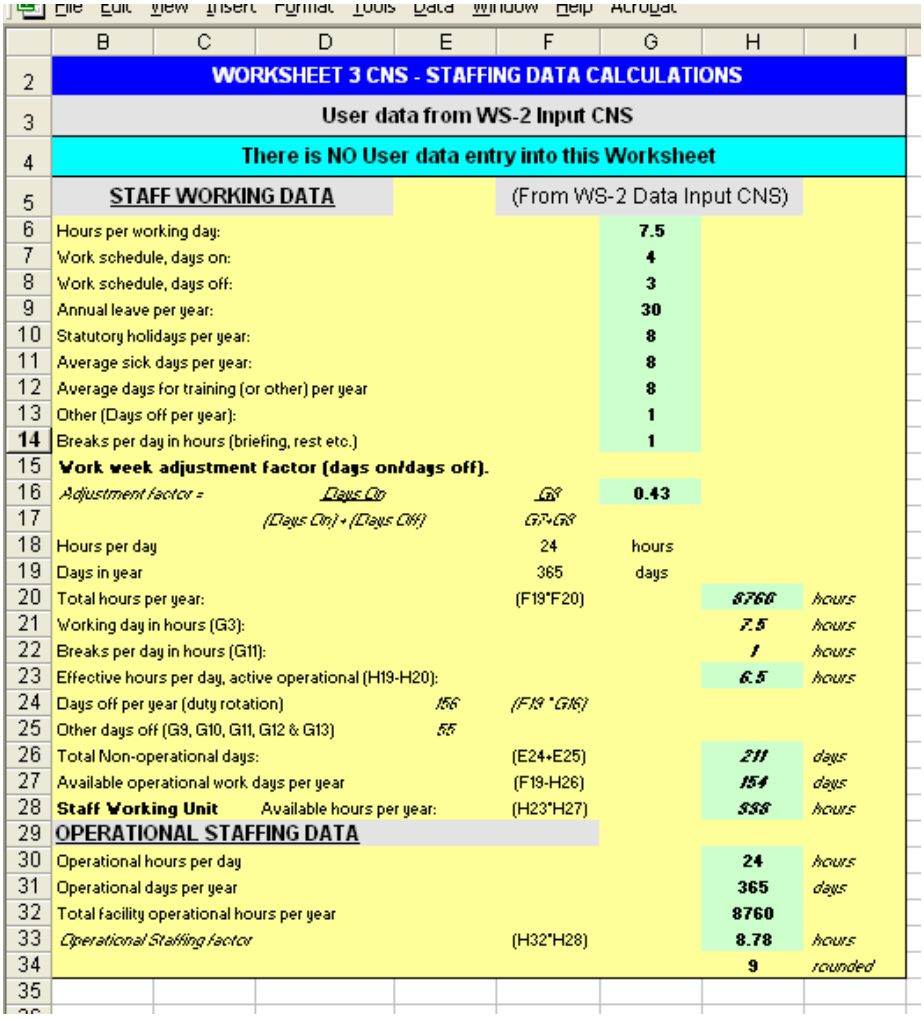


	B	C
2	**WORKSHEET 2 - CNS STAFFING DATA INPUT**	
3	**Enter data into Column "C"; P(ress [TAB] or [Shift] [Tab] to move between fields. Use File / Sava As, to save your work using a new file name. Save to an appropriate folder.**	
4	**Description of Data**	User Data Input
5	**PERSONNEL DATA**	
6	**Days per year:**	365
7	**Hours per day:**	24
8	**Hours per working day:**	7.5
9	**Work schedule, Days On:**	4
10	**Work schedule, Days Off:**	3
11	**Annual leave, Days per year:**	30
12	**Average sick days per year:**	8
13	**Statutory holidays per year:**	12
14	**Average training days per year:**	8
15	**Other (days off per year):**	1
16	**Breaks per working day in Hours:**	1
17	**OPERATIONAL DATA**	
18	**No. of staff on duty to cover Op. Requirements:**	6
19	**Operational days per year:**	365
20	**Operation hours/day:**	24

Figure 2, Worksheet 2 - CNS Data Input to Worksheet 3

Note: The data shown in Figure 2 are samples only and do not represent any actual working environment.

2.1.3 The data entered by a user into Figure 2, (*Worksheet 2*) is automatically linked to Figure 3 (*Worksheet 3,* CNS Maintenance Staffing Data). No user input is required for *Worksheet 3*.



	B	C	D	E	F	G	H	I
2	**WORKSHEET 3 CNS - STAFFING DATA CALCULATIONS**							
3	**User data from WS-2 Input CNS**							
4	**There is NO User data entry into this Worksheet**							
5	**STAFF WORKING DATA**				(From WS-2 Data Input CNS)			
6	Hours per working day:					**7.5**		
7	Work schedule, days on:					**4**		
8	Work schedule, days off:					**3**		
9	Annual leave per year:					**30**		
10	Statutory holidays per year:					**8**		
11	Average sick days per year:					**8**		
12	Average days for training (or other) per year					**8**		
13	Other (Days off per year):					**1**		
14	Breaks per day in hours (briefing, rest etc.)					**1**		
15	**Work week adjustment factor (days on/days off).**							
16	*Adjustment factor =*		*Days On*		*G8*	**0.43**		
17			*(Days On) + (Days Off)*		*G7+G8*			
18	Hours per day				24	hours		
19	Days in year				365	days		
20	Total hours per year:				(F19*F20)		*8760*	*hours*
21	Working day in hours (G3):						*7.5*	*hours*
22	Breaks per day in hours (G11):						*1*	*hours*
23	Effective hours per day, active operational (H19-H20):						*6.5*	*hours*
24	Days off per year (duty rotation)			*156*	*(F18 * G16)*			
25	Other days off (G9, G10, G11, G12 & G13)			*55*				
26	Total Non-operational days:				(E24+E25)		*211*	*days*
27	Available operational work days per year				(F19-H26)		*154*	*days*
28	**Staff Working Unit**		Available hours per year:		(H23*H27)		*998*	*hours*
29	**OPERATIONAL STAFFING DATA**							
30	Operational hours per day						**24**	*hours*
31	Operational days per year						**365**	*days*
32	Total facility operational hours per year						**8760**	
33	*Operational Staffing factor*				(H32*H28)		**8.78**	*hours*
34							**9**	*rounded*
35								

Figure 3 *Worksheet 3*, CNS Staffing data CALCULATIONS

2.1.4 The following three main factors of information are obtained from *Worksheet 3*:

a) Staff Working Unit (effective working hours per year per person) 998 **hours**
b) Operational Staffing Factor (total hours per year/effective hours per year) 8.78
c) Minimum staff required for a single function

2.2 CNS Equipment Statistics and the "*Task-Load"*

2.2.1 In the nest step, staffing requirements of a CNS maintenance organization are determined and related to the requirements for work to be carried out by the staff. This workload, that includes preventative and corrective maintenance, travel times and carrying out modifications to equipments, installation of equipments and training of equipments is known as the "*task-load*". It is this *task-load* that truly defines the work to be done and along with other data such as the *operational staffing factor* that aid in determining the staffing requirements.

2.2.1 In order to arrive at a reasonably accurate *task-load*, it is necessary to perform numerous analyses of the CNS equipments, these include:

a) Complete CNS equipment inventory database;
b) CNS Equipment Preventative Maintenance Programme;
c) CNS Equipment Corrective Maintenance Programme;
d) CNS Equipment Travel Time to Conduct Preventative Maintenance Programme; and
e) CNS Equipment Travel Time to Conduct Corrective Maintenance.

2.3 Determine CNS equipment maintenance "task-load"

2.3.1 With the data obtained as outline above (2.2.1), it is then possible to determining the CNS equipment maintenance "*task load*". An illustration of this approach is shown in paragraphs 2.3.2, 2.3.3 and 2.3.4. A more detailed approach is outlined in Chapter 8, Case Study.

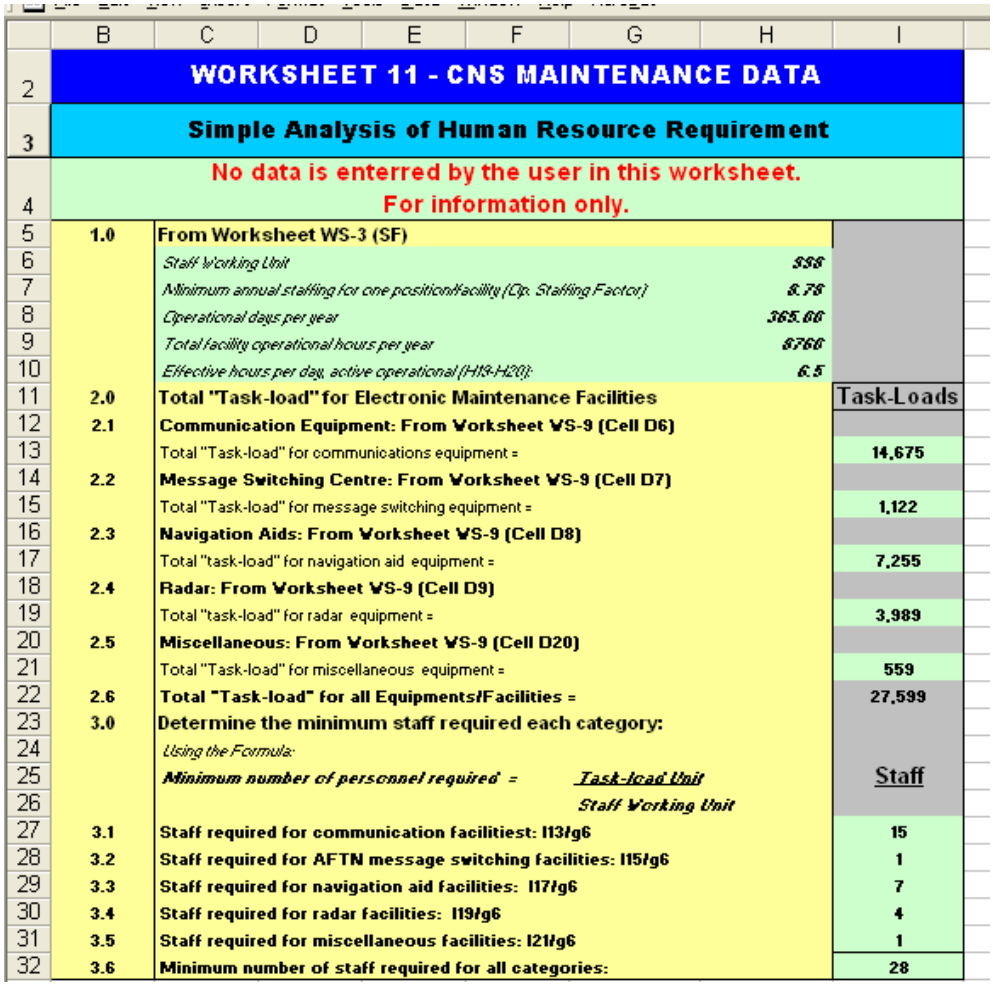
2.3.2 To determine an accurate "task-load" for a medium to large organization is a complex and lengthy task. The worksheets required to conduct this activity are identified in Table 1.

WORKSHEET	FUNCTION
1	CNS DIVISION PERSONNEL DATABASE
2	CNS STAFFING DATA INPUT
3	CNS - STAFFING DATA CALCULATIONS
4	CNS OPERATIONAL EQUIPMENT INVENTORY
5	CNS FACILITIES PREVENTATIVE MAINTENANCE
6	CNS FACILITIES CORRECTIVE MAINTENANCE
7	CNS FACILITIES PREVENTATIVE MAINTENANCE TRAVEL TIME
8	CNS FACILITIES CORRECTIVE MAINTENANCE TRAVEL TIME
9	CNS TOTAL MAINTENANCE IN HOURS
11	CNS SIMPLE ANALYSIS FOR STAFFING NEEDS

Table 1 Worksheets used for CNS Staffing Requirements

2.3.3 Figure 4 (*Worksheet11*) provides an analysis of the total maintenance requirements in hours for all of the CNS facilities of an organization. From these figures, a staff requirement can be determined. Additional calculations are required using the data from *Worksheet 11* plus the "staff working unit" obtained from *Worksheet 3*.

2.3.4 Staffing figures obtain at this stage do not take into account any rostering. The user must determine the rostering requirements (which are in support of operational requirements) along with staffing figures obtained from the *task-load* factor to obtain more realist staffing figures. All figures used in these worksheets are fictitious and do not represent any specific organization.



	B	C	D	E	F	G	H	I
2	**WORKSHEET 11 - CNS MAINTENANCE DATA**							
3	**Simple Analysis of Human Resource Requirement**							
4	No data is enterred by the user in this worksheet. For information only.							
5	**1.0**	**From Worksheet WS-3 (SF)**						
6		*Staff Working Unit*					*998*	
7		*Minimum annual staffing for one position/facility (Op. Staffing Factor)*					*8.78*	
8		*Operational days per year*					*365.00*	
9		*Total facility operational hours per year*					*8760*	
10		*Effective hours per day, active operational (H19-H20):*					*6.5*	
11	**2.0**	**Total "Task-load" for Electronic Maintenance Facilities**						Task-Loads
12	**2.1**	**Communication Equipment: From Worksheet WS-9 (Cell D6)**						
13		Total "Task-load" for communications equipment =						14,675
14	**2.2**	**Message Switching Centre: From Worksheet WS-9 (Cell D7)**						
15		Total "Task-load" for message switching equipment =						1,122
16	**2.3**	**Navigation Aids: From Worksheet WS-9 (Cell D8)**						
17		Total "task-load" for navigation aid equipment =						7,255
18	**2.4**	**Radar: From Worksheet WS-9 (Cell D9)**						
19		Total "task-load" for radar equipment =						3,989
20	**2.5**	**Miscellaneous: From Worksheet WS-9 (Cell D20)**						
21		Total "Task-load" for miscellaneous equipment =						559
22	**2.6**	**Total "Task-load" for all Equipments/Facilities =**						27,599
23	**3.0**	**Determine the minimum staff required each category:**						
24		*Using the Formula:*						
25		***Minimum number of personnel required' =***			***Task-load Unit***			Staff
26					***Staff Working Unit***			
27	**3.1**	**Staff required for communication facilitiest: I13/g6**						15
28	**3.2**	**Staff required for AFTN message switching facilities: I15/g6**						1
29	**3.3**	**Staff required for navigation aid facilities: I17/g6**						7
30	**3.4**	**Staff required for radar facilities: I19/g6**						4
31	**3.5**	**Staff required for miscellaneous facilities: I21/g6**						1
32	**3.6**	**Minimum number of staff required for all categories:**						28

Figure 4 (Worksheet 11) Analysis of human resource minimum requirement

3. Staff required to support Task-Loads and Rostering

3.1 Determine the Minimum Staff Required

3.1.1 To determine the number of staff required to support the maintenance of a CNS facility, the following data is derived from, *Worksheet 4(* Figure 4).

Item	Result
"Staff *working unit"*	998 hours (Worksheet 11 Cell F6)
Total "task-load "	27,599 hours (Worksheet 11 Cell I19)

Table 2

Staffing to support communications facilities

Communications facilities "*task-load*" = **14,475** hours = **14.5 staff**
"Staff working unit" **998**

Figure 5 Determine staffing for communications equipments

3.1.2 The figure of 14.5 staff in Figure 5 is round to "15". This states that a total of 15 staff are required to support the maintenance activities of all the communication equipment detailed in the inventory/maintenance analysis (*Worksheets 4 – 8*). The figure of 15 staff does not include any requirements for rostering. This is particularly true for example an AFTN facility.

4 Use of Partially Qualified staff Staff

4.1 OJT Personnel

4.1.1 The results outlined in paragraph 3 above are accomplished by using only fully qualified technical staff. The *staff working unit* (results in *Worksheet 3* of 998 available work hours) are based on this assumption. It will be necessary to make estimated adjustments of the staffing figures to reflect the use of non fully-qualified technical staff who are required to undergo on-the-job training.

4.1.2 To illustrate one approach that could be used to adjust staffing, the staff working unit of 998 hours could be reduced by a factor of 25% to reflect that all staff members are not fully qualified giving a result of 748 hours (998 x 0.25).

4.1.3 This assessment is based on the fact that while some useful work is obtained from such personnel, this time is counterbalanced by authorized absences for OJT training and assisting qualified personnel to carry out their functions. This is only an example and as mentioned above, the reduction factor would be dependent upon the numbers of unqualified staff and their qualifications.

4.2 Realistic Establishment of Human Resource Requirements

4.2.1 Planners are required to make realistic judgements when determining the final human resource establishment figures based on individual requirements at each particular site. Close liaison with technical and operational management is required to determine the technical coverage necessary to ensure safe and efficient operations.

4.2.2 In some cases, it may be appropriate to have lesser qualified personnel cover certain shift activities, provided there is a qualified technician on a "on-call" basis. On the other hand, the maintenance of some facilities (i.e. radar) may require the service of two qualified technicians on duty to handle specific maintenance activities. The maintenance philosophy of an organization and economics are also major factors in determining the human resource needs of a CNS technical support organization.