



Commonwealth of Australia

Australian Post Office

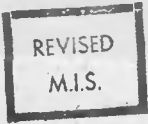
SPECIFICATION

1080

ISSUE 2

PABX DESIGN OBJECTIVES

Engineering Works Division, Headquarters, Melbourne.



NOTE

Corrigenda and Errata included following Appendix I

APO SPECIFICATION 1080 ISSUE 2
FOR
PABX DESIGN OBJECTIVES
CONTENTS

Table with 2 columns: Section/Item and Page. Includes sections like SECTION 1. SCOPE AND DEFINITIONS, SECTION 2. OPERATIONAL FEATURES, SECTION 3. FEATURE TECHNIQUES, SECTION 4. THE OPERATORS POSITION, SECTION 5. TRUNKING, GRADES OF SERVICE AND NUMBERING, SECTION 6. PHYSICAL DESIGN OF EQUIPMENT.

CONTENTS (CONTD.)

	<u>Page</u>
SECTION 7. RELIABILITY	
7.1 Reliability And Life	39
7.2 Environment	39
7.3 Components, Materials And Finishes	40
7.4 Switching Devices	41
7.5 Circuitry	41
7.6 Maintenance Equipment	41
SECTION 8. TRANSMISSION	
8.1 Introduction	42
8.2 General	42
8.3 Transmission Requirements	43
SECTION 9. SIGNALLING AND INTERFACE	
9.1 General	45
9.2 Decadic Signalling	46
9.3 Push-Button Signalling	48
9.4 MFC Signalling	48
9.5 Exchange Lines	48
9.6 Tie-Lines	51
9.7 Extension Lines	52
SECTION 10. COMMON SERVICES	
10.1 General	54
10.2 Ring	54
10.3 Tones	55
10.4 Other Signals	55
SECTION 11. POWER	
11.1 Power Supplies	56
11.2 Protection	56
SECTION 12. MAINTENANCE	
12.1 General	58
12.2 Access To PABX Equipment	59
12.3 Testing Equipment	59
12.4 Fault Recorders	61
12.5 Alarms	61
12.6 Centralised Maintenance Requirements	63
12.7 Traffic Measuring	64

CONTENTS (CONTD.)

Page

SECTION 13. DOCUMENTATION

13.1	General	65
13.2	General Description	65
13.3	Circuit Description	66
13.4	Drawings	66
13.5	Installation Information	67
13.6	Maintenance Information	67
13.7	Operating Instructions	68

SECTION 14. ASSOCIATED REFERENCES

14.1	References	69
------	------------------	----

SECTION 15. GENERAL

15.1	Changes to Issue 1	71
------	--------------------------	----

APPENDIX 1. MEETING OF CALLS ON BOTHWAY CIRCUITS

73

TABLE

1	Feature List A - Non-Extendable, up to Approximately 26 Extension Lines	11
2	Feature List B - Up to Approximately 100 Extensions Lines	12
3	Feature List C - Over Approximately 100 Extensions Lines	13
4	Feature List D - Operators Position	14
5	Feature List E - Optional	15
6	Extension Classifications	18
7	Trunk Access Barring Arrangements	19
8	Time Consistent Busy Hour Traffic	34
9	Small Fixed Dimension PABX Capacities	35
10	Numbering Plan and Access Codes	35
11	Mean Time Between Catastrophic Failures	39
12	Transmission Test Points	42
13	Reference Equivalents of 800 Series Telephones on Zero Lines with Various Feed Currents	43
14	PABX Line Signals	45
15	Acceptable Pulse Distortion	46
16	Types of Exchange Line Circuits	47
17	Maintenance Aids	58
18	Summary of Alarms	62

FIGURE

1	Rating of Ringers	55
---	-------------------------	----

PABX DESIGN OBJECTIVES

SECTION 1. SCOPE AND DEFINITIONS

1.1 SCOPE

- 1.1.1 This specification defines the APO design objectives for PABX equipment to be installed in accordance with APO Specification 1071.
- 1.1.2 For the purpose of PABX equipment design for particular installations this specification takes precedence over all other specifications.
- 1.1.3 The specification deals exclusively with design objectives. Methods of testing equipment against this specification are not included.
- 1.1.4 It is intended as a guide for the development of new equipment and the upgrading of existing equipment. It should not be interpreted as setting a precise and rigid pattern for all future equipment. Rather it should be taken as a statement of APO objectives, taking into account the technical capabilities and cost of existing technology. Where a significant change occurs in technology, variations to features and techniques may be justified.

1.2 DEFINITIONS

- 1.2.1 Dial Tone Delay The period from the establishment of a loop by the extension telephone to the time when dial tone is fed to the extension line.
- 1.2.2 Effective Reference Equivalent CCITT NOSFER reference equivalents modified on the sending side by -1.4 db to account for the difference between the NOSFER and in-service speaking distances with 800 series telephones.
- 1.2.3 Failure Any equipment condition which is not due to a traffic overload but which causes a break or deterioration in service and includes no service on one or more extension, exchange or tie lines. Such conditions would normally require an unscheduled visit of a repairman.
- 1.2.4 Failure, Catastrophic An equipment failure which causes a severe and prolonged break or deterioration in service, and occurs when more than 50% of total calls or of one or more of the following types of call fail to mature correctly or experience a dial tone delay or switching delay of more than 10 seconds and this condition continues for more than 2 minutes:
 - internal
 - incoming exchange to operator
 - indialling
 - outgoing exchange
- 1.2.5 Feature, Available A feature that must be able to be readily provided when required, e.g. by plugging in additional circuit packages or by re-arranging strappings.
- 1.2.6 Feature, Essential A feature that must always be provided.
- 1.2.7 Feature, Not necessary A feature of an AL or BL PABX that will be acceptable if it is part of the equipment and does not cause any increase in costs.
- 1.2.8 Feature, Not required A feature that should be excluded from the PABX design.
- 1.2.9 Feature, Optional A feature not classified essential or available and which is provided to meet the requirements of particular users.
- 1.2.10 Line Lock-out A circuit condition applied to an extension line when the extension line remains looped after the switching equipment has released.
- 1.2.11 PABX Type A particular grouping of electrical and mechanical components and circuits into a switching system giving prescribed features, circuit and traffic capacity. It may have a range of circuit capacities and trunking arrangements but a change of capacity shall not require a change or replacement of previously installed equipment.
- 1.2.12 Post Dialling Delay The time between completion of dialling an internal PABX number or the exchange access digit, and the connection of the service tone.
- 1.2.13 Switching Delay The time between the receipt of address information to permit switching and the establishment of the switching path through the exchange.
- 1.2.14 Tie Line A line that provides a telephone circuit between PBX equipments without through the public exchange switching network.
- 1.2.15 Traffic and trunking terms which are not included in this section are defined in Glossaries, Planning, T0010

SECTION 2. OPERATIONAL FEATURES

2.1 EXPLANATION

- 2.1.1 The operational features required for various PABX types are listed in Tables 1 to 5 which are Feature Lists A to E inclusive.
- 2.1.2 The features listed in Tables 1 to 5 are described in Clause 2.2. The detailed techniques of essential and available features are given in the sections referred to in the tables. Techniques for optional features are not specified.
- 2.1.3 Feature List A (Table 1) This covers PABX types up to 26 extension lines and 6 bothway exchange lines. Two lists are included, AL, without an operators position and with limited features to provide a minimum cost PABX, and AU the unlimited feature version.
- 2.1.4 Feature List B (Table 2) This covers PABX types up to approximately 100 extension lines. Two lists are included, BL with limited features to provide a minimum cost PABX, and BU the unlimited feature version.
- 2.1.5 Feature List C (Table 3) This covers PABX types over approximately 100 extension lines. Only one version is specified.
- 2.1.6 Feature List D (Table 4) This covers the operators position features for Feature Lists A to C.
- 2.1.7 Feature List E (Table 5) Optional features for AU, BU and C lists.

2.2 DESCRIPTIONS

- 2.2.1 Abbreviated Code Calling Extensions gain access to internal or public exchange addresses that are predetermined for each extension, by using special codes.
- 2.2.2 Add on Enquiry An extension during an enquiry call brings the exchange call into simultaneous transmission with both extensions.
- 2.2.3 Advice Call A connection from a PABX operators position to an extension of the same PABX.
- 2.2.4 Assistance Call A connection from an extension to the PABX operator.
- 2.2.5 Automatic Call Back An extension, after attempting an internal call to a busy extension, has the call automatically established when the called extension becomes idle.
- 2.2.6 Automatic Change of Nightservice Automatic change from any one nightservice mode (e.g. selected nightservice) to any other (e.g. remote alarm nightservice). The change may be activated by volume of unanswered incoming calls or by a pre-set time control.
- 2.2.7 Automatic Conference Extensions establish a conference call.
- 2.2.8 Automatic Operator Recall An incoming or reverted call is redirected to the operators position if the called extension has not answered within a prescribed time.
- 2.2.9 Automatic Transfer An extension redirects a matured exchange call to another extension or an operator.
- 2.2.10 Blind Operator Aids Visual call signals to the operators position are supplemented by tones that indicate the location of the control functions.
- 2.2.11 Bothway Dialling Tie Lines Circuits between PABX installations that enable extensions on each PABX to directly dial an extension on the other.
- 2.2.12 Broker's Enquiry On an enquiry call, unlimited alternation between the exchange call and the enquiry call without releasing either.
- 2.2.13 Busy Extension Display An array of designated lamps, one per extension, on or near the operators position, which glow to indicate the occupancy of each extension line.
- 2.2.14 Call Address Recording A surveillance feature which records the originating and called addresses and the time and duration of a call.
- 2.2.15 Call Count Display An indication at one (supervisors) position of the number of calls of each type that are awaiting attention by operators.

- 2.2.16 Call Distribution With link appearance, ensures suitable allocation of calls to staffed operators positions.
- 2.2.17 Call Metering An extension has a counter which operates on outgoing exchange calls in synchronism with the public exchange meter registrations.
- 2.2.18 Call Waiting An indication is given to a busy extension that an incoming exchange call is waiting and permits the user to "hold" the existing call and answer the exchange call.
- 2.2.19 Camp-on-Busy An incoming call via the operator, requiring connection to an engaged extension, is set up automatically without re-keying as soon as the wanted extension becomes idle.
- 2.2.20 Centralised Dictation Access Internal calls are made to a nominated address with further signalling through the PABX to control a centralised dictation system.
- 2.2.21 Combined Nightservice The combination of two or more types of nightservice.
- 2.2.22 Conference Call A connection which permits simultaneous transmission between 3 or more users (excluding the operator).
- 2.2.23 Data Access Internal data calls are made from certain extensions to data equipment.
- 2.2.24 Decadic Signalling Signalling using decadic loop disconnect pulses, e.g. from a rotary dial.
- 2.2.25 Denied Classification An extension cannot be connected to an exchange line, but has access to the other features of the PABX.
- 2.2.26 Dial-In/Ring-Out Tie Lines Circuits from other PBXs that permit direct dialling into the PABX and allow access from the PABX extensions to another PBX operators position.
- 2.2.27 Direct Access An extension can make some internal calls by the operation of one of a number of buttons each corresponding to a particular extension.
- 2.2.28 Direct Appearance of exchange line and other circuits. The physical location of the signalling indicators and controls for each circuit on each operators position are fixed according to the installed pattern.
- 2.2.29 Direct Extension Selection The operators position is provided with a calling key for each extension.
- 2.2.30 Directed Nightservice Individual nightservice except that the extension to answer incoming calls on each exchange line may be one of several extensions which is preselected by a multi-way control mounted on or near the operators position.
- 2.2.31 Divided Working The operator, whilst setting up incoming and reverted calls may converse independently with either party whilst the other is held.
- 2.2.32 Doctor's Nightservice Selected nightservice except that the extension to answer all incoming calls may be one of several extensions and is preselected by a multi-way control mounted on or near the operators position.
- 2.2.33 Enquiry Call A connection set up by an extension, whilst holding another call, usually an incoming exchange call. The enquiry call is usually an internal call but exchange access from enquiry may be available.
- 2.2.34 Exchange Access from Enquiry An extension originates an outgoing exchange call from an enquiry call.
- 2.2.35 Exchange Decadic Signalling Outgoing exchange calls have the address information conveyed from the PABX to the public exchange by decadic loop disconnect signals.
- 2.2.36 Exchange Keysender Each operators position is provided with a decadic array of digit buttons which the operator uses to enter the address of a call from the position to the public exchange.
- 2.2.37 Exchange Line Identification The identification of the exchange line that is connected to the operators circuit is displayed on the operators position.
- 2.2.38 Exchange Line Status Display An indication on the operators position of the occupancy of each exchange line to which the operators position has access.
- 2.2.39 Exchange MFC Signalling Outgoing exchange calls have the address information conveyed from the PABX to the public exchange by multi-frequency code signals. The PABX carry out some network analysis functions.

- 2.2.40 Exchange Tone Signalling Outgoing exchange calls have the address information conveyed from the PABX to the public exchange by push-button telephone tone signals.
- 2.2.41 Executive Classification Assistance calls to the operator are indicated in a distinctive manner.
- 2.2.42 Extended Tie Line Call A connection resulting from either:
 an incoming exchange line call received at its PABX answering point, then extended, or transferred, from that point to another PBX; or
 an indialled call through the PABX to another PBX.
- 2.2.43 Extension Number Display A numerical indication on a position that shows the address number of the extension connected to the operators circuit.
- 2.2.44 Extension Number Translator Converts directory addresses to equipment addresses to give flexible numbering plans without wastage, and more even distribution of traffic without number changes.
- 2.2.45 Extension Status Display An alpha-numeric or coded lamp indication on a position that shows the classification and occupancy of the extension connected to the operators circuit.
- 2.2.46 External Extensions Extensions that are not on the same property as the PABX equipment and are often provided via public network cabling.
- 2.2.47 Group Diversion Calls to any of a group of extensions ring the called extension and then, if unanswered, simultaneously ring another answering extension for the group. At the group answering point the called address is identified.
- 2.2.48 Group Identification With link appearance, provision is made on each operators position to identify before answer, the address by which the call has arrived at the position.
- 2.2.49 Group Nightservice Incoming exchange calls are offered to a group of extensions for connection to a free extension for answer. When all extensions are busy a subsequent call is stored until an extension in the group becomes idle or the call is abandoned.
- 2.2.50 Group Search A call to an extension is switched to an idle extension in a group of two or more extensions.
- 2.2.51 Headset A transmitter and receiver in a combined light weight head fitting.
- 2.2.52 Hotel Dialling Extensions address internal calls to a limited number of addresses by dialling or keying a single digit.
- 2.2.53 Identified Outward Dialling The automatic billing of all charged calls against the originating address (extension number or operators position) and if required the identification of the exchange line passing the call.
- 2.2.54 Incoming Exchange Call A connection which originates in the public exchange network and arrives at a PABX answering point. This type of call is usually extended from the answering point to an extension.
- 2.2.55 Incoming Exchange Call Queueing Incoming exchange calls are served in order of arrival at link appearance operating positions.
- 2.2.56 Incoming Tie Line Call A direct connection from another PBX to the operator or an extension of the PABX.
- 2.2.57 Indialled Access to Operator A common indialling group of circuits from the public exchange network for all extension numbers and also selection within the PABX for calls addressed to the operators positions.
- 2.2.58 Indialling Incoming exchange calls are directed by callers to PABX extensions without operator assistance.
- 2.2.59 Indialling Decadic Indialling where the address signals between the public exchange and PABX are decadic signals.
- 2.2.60 Indialling MFC Indialling where the address signals between the public exchange and PABX are multi-frequency code signals.
- 2.2.61 Individual Diversion Calls to an extension ring that extension and if unanswered simultaneously ring another extension.

- 2.2.62 Individual Nightservice Incoming calls on particular exchange lines are connected to particular pre-selected extensions.
- 2.2.63 Internal Call A connection between extensions connected to the same PABX.
- 2.2.64 Internal Keysender Each operators position is provided with a decadic array of digit buttons which the operator uses to enter the address of a call from the position to an extension.
- 2.2.65 Link Appearance Exchange line and other circuits to and from the operators are connected through a switching stage to operators connecting circuits which are individual to each position.
- 2.2.66 Link Availability With link appearance, at least one link on each operators position is always available for automatic operator recall.
- 2.2.67 Manual Conference A connection established from the operators position which permits simultaneous transmission between three or more other parties.
- 2.2.68 Message Waiting The operator, or an attendant at another location, controls a lamp on an extension telephone to indicate that there is a message for the telephone user.
- 2.2.69 Mobile Radio Access Internal calls are made to a nominated address with further signalling through the PABX to control press-to-talk half-duplex radio transmissions.
- 2.2.70 Nightservice Incoming exchange calls which would otherwise be answered at an operators position are automatically connected to extensions.
- 2.2.71 Open Classification An extension has access to all the features of the PABX.
- 2.2.72 Operator Alarm A switch controlled audible alarm provided on or near the operators position to indicate any call requiring the attention of the operator.
- 2.2.73 Operator Monitoring An operator may listen to an incoming or reverted call that has been connected through the operators position.
- 2.2.74 Operator Restriction of Access The classification of extensions may be changed from open to restricted external by a control on the operators position.
- 2.2.75 Operator Tie-Lines Circuits from PBX installations that terminate on the PABX operators position so that tie line calls may be connected to extensions by the operator.
- 2.2.76 Operators Position A control and supervisory device having access to circuits which allow an operator to initiate, receive and manually control various types of calls through the PABX.
- 2.2.77 Outgoing Enquiry An extension may establish an enquiry call whilst holding an outgoing exchange call.
- 2.2.78 Outgoing Exchange Call A connection established from an extension by signalling the public exchange access code. The extension may then, according to its classification, have further access to network facilities.
- 2.2.79 Outgoing Tie-Line Call A connection established from an extension by signalling the tie line access code, to connect to the distant PBX operator or, by then signalling the address number, to an extension of the other PABX.
- 2.2.80 Outgoing Transfer Automatic transfer of an outgoing exchange call.
- 2.2.81 Overlapping The operator may monitor calls temporarily terminated at the operators position whilst operating on other calls.
- 2.2.82 Paging Access Internal calls are made to nominated addresses with further signalling through the PABX to control visual display or personal calling paging systems.
- 2.2.83 Paging Answer An internal call is made to a nominated address to automatically connect to a call being announced by the paging system.
- 2.2.84 Power Fail Transfer Exchange lines are connected to individual telephones when the supply voltage is removed from the PABX.
- 2.2.85 Priority Break-in Extensions are connected to a busy extension and enter into the transmission providing the existing connection is not an exchange call.

- 2.2.86 Public Address Access Internal calls are made to a nominated address for verbal paging from the calling telephone to a public address system.
- 2.2.87 Pursue Me Calls to an extension which is temporarily unattended are diverted to another extension.
- 2.2.88 Push Button Signalling The users of appropriately equipped extension telephones address calls (and may transmit casual data) by the operation of digit buttons.
- 2.2.89 Rapid Call Keys The operator can call frequently wanted public exchange addresses by means of a key controlled repertory dialler.
- 2.2.90 Remote Alarm Nightservice A nightservice incoming exchange call operates a system of alarms until someone answers the call by calling an access code from an extension.
- 2.2.91 Reset An internal call to a busy address is re-directed to another address of which only the units digit is different from the address originally called, by dialling (or keying) only the new last digit within a prescribed period.
- 2.2.92 Restricted External Classification Extensions cannot make direct outgoing exchange calls but have access to the other facilities of the PABX.
- 2.2.93 Restricted Internal Classification Internal calls between extensions must be set up by the operator.
- 2.2.94 Reverted Call A connection established from a PABX operators position, first to the public exchange or to another PBX via a tie line, then to a PABX extension. The operator usually completes the signalling in both directions.
- 2.2.95 Reverted Call Metering A counter provided on the operators position operates on reverted calls in synchronism with the public exchange meter registrations.
- 2.2.96 Satellite Working The PABX operates without an operators position and receives its incoming exchange calls as extended tie-line calls from another (Parent) PABX.
- 2.2.97 Secretarial Hunting Particular extensions are a common last choice in two or more hunting groups.
- 2.2.98 Selected Nightservice Incoming exchange calls are connected to one pre-selected extension. If the extension is busy, a call is stored until the extension becomes idle or the call is abandoned.
- 2.2.99 Serial Call An exchange call is held by the operator for resignalling to the operators position when the extension releases, so that the call may be then connected to another extension.
- 2.2.100 Supervisors Position A special position having call count and other visual displays to indicate the working status of each of the operators positions. Bothway order-wire access may be required between each operators position and the supervisors position, which should also be capable of handling incoming calls transferred to it from any operators position.
- 2.2.101 Through Dialling on a reverted call. The extension addresses the public exchange network number.
- 2.2.102 Trunk Barred Classification Extensions are prevented from directly originating any trunk calls.
- 2.2.103 Trunk Booking Position An operating position provided in conjunction with multiple position suites to facilitate the connection of trunk calls. Assistance calls to it preferably have a different address code from other operators and it is generally provided with a separate group of incoming exchange lines.
- 2.2.104 Trunk Offering An operator may connect to an extension that is engaged on a call to advise the extension user of a waiting incoming or reverted call.
- 2.2.105 Trunk Route Barred Classification Extensions are permitted to establish subscriber trunk dialled calls on selected routes or to selected addresses, and are prevented from making other STD calls.
- 2.2.106 Unanswered Indial Diversion Indialled calls signal to an operator as well as the called extension, if the extension has not answered after a pre-determined time.
- 2.2.107 Watchman's Control Internal calls are made from any extension to a watchman's control system, which records the calling extension number and the time the call was placed.

TABLE 1

FEATURE LIST A

NON-EXTENDABLE PABX TYPES WITH UP TO APPROXIMATELY 26 EXTENSION LINES
AND 6 BOTHWAY EXCHANGE LINES

Item	Feature	Description	Technique	Classification	
				AL	AU
1	Internal Call	2.2.63	3.1.12	Essential	Essential
2	Push Button Signalling	2.2.88	9.3	Only as a complete alternative	Available
3	External Extensions	2.2.46	9.7.3	Not Necessary	Essential
4	Incoming Exchange Call	2.2.54	3.3.1	Essential	Essential
5	Operators Position	2.2.76	4.	Not Required	Available - See List D
6	Advice Call	2.2.3	3.3.4	Not Required	Essential with Item 5
7	Remote Alarm Nightservice	2.2.90	3.5.7	Essential	Available
8	Selected Nightservice	2.2.98	3.5.8	Essential	Essential
9	Doctor's Nightservice	2.2.32	3.5.9	Not Required	Available
10	Group Nightservice	2.2.49	3.5.10	Not Required	Available
11	Individual Nightservice	2.2.62	3.5.12	Not Required	Available
12	Outgoing Exchange Calls	2.2.78	3.1.12	Essential	Essential
13	Open Classification	2.2.71	3.2.1	Essential	Essential
14	Restricted External Classification	2.2.92	3.2.3	Essential	Essential
15	Denied Classification	2.2.25	3.2.4	Not Necessary	Available
16	Trunk Barred Classification	2.2.102	3.2.5	Available	Available
17	Call Address Recording	2.2.14	3.7.1	Available	Available
18	Call Metering	2.2.17	3.7.2	Not Required	Available
19	Enquiry Call	2.2.33	3.4.1	Essential	Essential
20	Automatic Transfer	2.2.9	3.4.4	Essential	Essential
21	Assistance Call	2.2.4	3.3.3	Not Required	Essential with Item 5
22	Reverted Call	2.2.94	3.3.2	Not Required	Essential with Item 5
23	Outgoing Tie-Line Call	2.2.79	9.6	Not Required	Available
24	Incoming Tie-Line Call	2.2.56	9.6	Not Required	Available
25	Individual Diversion	2.2.61	3.4.7	Not Required	Available
26	Data Access	2.2.23	3.2.13	Not Required	Available
27	Power Fail Transfer	2.2.84	3.4.15	Essential	Essential
28	Any Other Features	-	-	Not Required	Optional - See List E

TABLE 2

FEATURE LIST B

PABX TYPES WITH UP TO APPROXIMATELY 100 EXTENSION LINES

Item	Feature	Description	Technique	Classification	
				BL	BU
1	Internal Call	2.2.63	3.1.12	Essential	Essential
2	Push Button Signalling	2.2.88	9.3	Only as a complete alternative	Available
3	External Extensions	2.2.46	9.7.3	Not Necessary	Essential
4	Incoming Exchange Call	2.2.54	3.3.1	Essential	Essential
5	Operators Position	2.2.76	4.	Essential - See List D	Available - See List D
6	Advice Call	2.2.3	3.3.4	Essential	Essential with Item 5
7	Individual Nightservice	2.2.62	3.5.12	Essential	Available
8	Selected Nightservice	2.2.98	3.5.8	Not Required	Essential
9	Doctor's Nightservice	2.2.32	3.5.9	Not Required	Available
10	Group Nightservice	2.2.49	3.5.10	Not Required	Available
11	Remote Alarm Nightservice	2.2.90	3.5.7	Not Required	Available
12	Combined Nightservice	2.2.21	3.5.13	Not Required	Available
13	Indialling	2.2.58	3.6	Not Required	Available
14	Outgoing Exchange Call	2.2.78	3.1.12	Essential	Essential
15	Open Classification	2.2.71	3.2.1	Essential	Essential
16	Restricted External Classification	2.2.92	3.2.3	Essential	Essential
17	Operator Restriction of Access	2.2.74	4.2.14	Not Required	Available
18	Denied Classification	2.2.25	3.2.4	Not Necessary	Available
19	Trunk Barred Classification	2.2.102	3.2.5	Available	Available
20	Call Address Recording	2.2.14	3.7.1	Available	Available
21	Call Metering	2.2.17	3.7.2	Not Required	Available
22	Enquiry Call	2.2.33	3.4.1	To operator only	Essential
23	Automatic Transfer	2.2.9	3.4.4	Not Required	Essential
24	Assistance Call	2.2.4	3.3.3	Essential	Essential with 5
25	Reverted Call	2.2.94	3.3.2	Essential	Essential with 5
26	Operator Tie-Lines	2.2.75	9.6	Available	Available with 5
27	Dial in/Ring Out Tie-Lines	2.2.26	9.6	Not Required	Essential
28	Bothway Dialling Tie-Lines	2.2.11	9.6.6&10	Not Required	Available
29	Extended Tie-Line Call	2.2.42	9.6.1	Not Required	Available
30	Conference Call	2.2.22	3.4.12	Not Required	Available subject to cost
31	Individual Diversion	2.2.61	3.4.7	Not Required	Available
32	Automatic Call Back	2.2.5	3.4.6	Not Required	Available
33	Group Search	2.2.50	3.4.8	Not Required	Available
34	Abbreviated Code Calling	2.2.1	3.4.10	Not Required	Available
35	Data Access	2.2.23	3.2.13	Not Required	Available
36	Power Fail Transfer	2.2.84	3.4.15	Essential	Essential
37	Any other Features	-	-	Not Required	Optional - See List E

TABLE 3

FEATURE LIST C

PABX TYPES WITH OVER APPROXIMATELY 100 EXTENSION LINES

Item	Feature	Description	Technique	Classification
1	Internal Call	2.2.63	3.1.2	Essential
2	Decadic Signalling	2.2.24	3.1.14	Interface essential
3	Push Button Signalling	2.2.88	9.3	Available - could be normal method.
4	Direct Access	2.2.27	3.4.11	Available for some extensions.
5	External Extensions	2.2.46	9.7	Essential
6	Incoming Exchange Call	2.2.54	3.3.1	Essential
7	Operators Position	2.2.76	4.	Essential - except for complete indialling.
8	Operator Features	-	3.3	See Feature List D.
9	Advice Call	2.2.3	3.3.4	Essential
10	Individual Nightservice	2.2.62	3.5.12	Available
11	Selected Nightservice	2.2.98	3.5.8	Essential
12	Doctor's Nightservice	2.2.32	3.5.9	Available
13	Group Nightservice	2.2.49	3.5.10	Available
14	Remote Alarm Nightservice	2.2.90	3.5.7	Available
15	Indialling Decadic	2.2.59	3.6 & 9.5.7	Available
16	Indialling MFC	2.2.60	3.6 & 9.4.3	Available
17	Indialled Access to Operator	2.2.57	3.6	Available
18	Outgoing Exchange Call	2.2.78	3.1.2	Essential
19	Exchange Decadic Signalling	2.2.35	9.2	Essential
20	Exchange Tone Signalling	2.2.40	9.3	Available subject to cost.
21	Exchange MFC Signalling	2.2.39	9.4	May be required for some large PABXs.
22	Open Classification	2.2.71	3.2.1	Essential
23	Restricted External Classification	2.2.92	3.2.3	Essential
24	Operator Restriction of Access	2.2.74	4.2.14	Available
25	Denied Classification	2.2.25	3.2.4	Available
26	Trunk Barred Classification	2.2.102	3.2.5	Available
27	Call Address Recording	2.2.14	3.7.1	Available
28	Call Metering	2.2.17	3.7.2	Available
29	Enquiry Call	2.2.33	3.4.1	Essential
30	Add On Enquiry	2.2.2	3.4.14	Available subject to cost.
31	Automatic Transfer	2.2.9	3.4.4	Essential
32	Assistance Call	2.2.4	3.3.3	Essential
33	Reverted Call	2.2.94	3.3.2	Essential
34	Operator Tie-Lines	2.2.75	9.6	Available
35	Dial in/Ring Out Tie-Lines	2.2.26	9.6	Essential
36	Bothway Dialling Tie-Lines	2.2.11	9.6.6&10	Available
37	Extended Tie-Line Call	2.2.42	9.6.1	Available
38	Manual Conference Call	2.2.67	3.4.13	Available subject to cost.
39	Individual Diversion	2.2.61	3.4.7	Available
40	Automatic Call Back	2.2.5	3.4.6	Available
41	Group Search	2.2.50	3.4.8	Available
42	Abbreviated Code Dialling	2.2.1	3.4.10	Available
43	Data Access	2.2.23	3.2.13	Available
44	Extension Number Translator	2.2.44	3.4.9	Available
45	Any Other Features	-	-	Optional See List E.

TABLE 4

FEATURE LIST D

OPERATORS POSITION

Item	Feature	Description	Technique	Classification			
				AU	BL	BU	C
1	Direct Extension Selection	2.2.29	3.3.1 4.2.1	Essential	Alternative to Item 2	Available	Optional
2	Internal Keysender	2.2.64	3.3.1 4.3.4	Not Required	Alternative to Item 1	Essential	Essential
3	Exchange Keysender	2.2.36	4.3.4	Optional	Optional with 2	Optional	Available
4	Direct Appearance	2.2.28	4.2.1	Essential	Essential	Essential	Alternative to 5
5	Link Appearance	2.2.65	4.2.6	Not Required	Not Required	Not Required	Alternative to 4
6	Trunk Offering	2.2.104	3.3.5	Essential	Essential	Essential	Essential
7	Camp-on-Busy	2.2.19	3.3.6	Essential	Not Required	Essential	Essential
8	Automatic Operator Recall	2.2.8	3.3.7	Essential	Not Required	Essential	Essential
9	Divided Working	2.2.31	3.3.8	Essential	Not Required	Essential	Essential
10	Overlapping	2.2.81	3.3.9	Essential	Essential	Essential	Essential
11	Serial Call	2.2.99	3.3.10	Available	Not Required	Available	Available
12	Blind Operator Aids	2.2.10	4.5.4	Available	Optional	Available	Available
13	Operator Restriction of Access	2.2.74	4.2.14	Optional	Not Required	Available	Available
14	Call Distribution	2.2.16	4.2.7	Not Required	Not Required	Not Required	Essential with 5
15	Link Availability	2.2.66	4.2.8	Not Required	Not Required	Not Required	Essential with 5
16	Group Identification	2.2.48	4.2.9	Not Required	Not Required	Not Required	Available with 5
17	Extension Status Display	2.2.45	4.4.4	Essential	Essential	Essential	Essential
18	Exchange Line Status Display	2.2.38	4.2.10	Essential	Essential	Essential	Essential
19	Exchange Line Identification	2.2.37	4.2.11	Essential	Essential	Essential	Essential
20	Headset	2.2.51	4.3.5	Not Required	Available	Available	Essential
21	Operator Alarm	2.2.72	4.5.1	Essential	Essential	Essential	Available
22	Call Count Display	2.2.15	4.4.5	Not Required	Not Required	Not Required	Available
23	Extension Number Display	2.2.43	4.4.3	Optional	Optional with 1	Available	Available
24	Busy Extension Display	2.2.13	4.4.2	Optional	Optional with 1	Available	Optional
25	Supervisors Position	2.2.100	4.4	Not Required	Not Required	Not Required	Available
26	Trunk Booking Position	2.2.103	4.4	Not Required	Not Required	Not Required	Available

TABLE 5

FEATURE LIST E

OPTIONAL FEATURES FOR AU, BU AND C LISTS

Item	Feature	Description	Remarks
1	Direct Access	2.2.27	Available for C
2	Busy Extension Display	2.2.13	Available for BU
3	Extension Number Display	2.2.43	Available for BU and C
4	Exchange Keysender	2.2.36	Available for C
5	Operator Monitoring	2.2.73	
6	Directed Nightservice	2.2.30	
7	Combined Nightservice	2.2.21	Available for BU
8	Automatic Change of Nightservice	2.2.6	
9	Unanswered Indial Diversion	2.2.106	
10	Exchange Tone Signalling	2.2.40	Available with C subject to cost
11	Trunk Route Barred Classification	2.2.105	
12	Add On Enquiry	2.2.2	Available with C subject to cost
13	Exchange Access from Enquiry	2.2.34	
14	Outgoing Enquiry	2.2.77	
15	Outgoing Transfer	2.2.80	
16	Broker's Enquiry	2.2.12	
17	Through Dialling	2.2.101	
18	Reverted Call Metering	2.2.95	
19	Manual Conference	2.2.67	Available with C
20	Automatic Conference	2.2.7	
21	Pursue Me	2.2.87	
22	Group Diversion	2.2.47	
23	Automatic Call Back	2.2.5	Available with BU and C
24	Priority Break In	2.2.85	
25	Call Waiting	2.2.18	
26	Group Search	2.2.50	Available with BU and C
27	Secretarial Hunting	2.2.97	
28	Reset	2.2.91	
29	Executive Classification	2.2.41	
30	Extension Number Translator	2.2.44	Available with C
31	Paging Access	2.2.82	
32	Paging Answer	2.2.83	
33	Public Address Access	2.2.86	
34	Centralised Dictation Access	2.2.20	
35	Mobile Radio Access	2.2.69	
36	Watchman's Control	2.2.107	
37	Hotel Dialling	2.2.52	
38	Restricted Internal Classification	2.2.93	
39	Message Waiting	2.2.68	
40	Incoming Exchange Call Queueing	2.2.55	
41	Satellite Working	2.2.96	
42	Identified Outward Dialling	2.2.53	

SECTION 3. FEATURE TECHNIQUES

3.1 CALL ESTABLISHMENT AND TONES

- 3.1.1 Exchange Connections PABX switching requirements that affect the establishment of public exchange calls are given in Clauses 3.1.2 and 3.1.3.
- 3.1.2 It shall not be possible to intentionally, or accidentally, or by misoperation, switch any exchange lines together or to any non-exchange access tie line.
- 3.1.3 It shall not be possible for an incoming exchange call to be "lost" except if it is unanswered by the extension or operator and abandoned by the exchange party, or is forcibly released by the operation of a key at the operators position, or it is extended to an extension, answered, then cleared by the extension. In all other cases, except indialled calls (see Clause 3.6.4) it shall revert to the operators position as an automatic operator recall.
- 3.1.4 General Use of Tones In the absence of recorded announcements, the supervisory tones defined in Clauses 3.1.5 to 3.1.11 shall be transmitted to the caller to indicate the progress with the establishment of a call. (Also see Clause 10.3).
- 3.1.5 Dial Tone The caller may proceed to originate address information.
- 3.1.6 Busy Tone The current call attempt is valid but will have to be repeated, or the extension has been connected to line lock-out.
- 3.1.7 NU Tone The current call attempt is invalid and cannot succeed even if repeated.
- 3.1.8 Ringling Tone The connection through the equipment has been established and the calling condition has been set up.
- 3.1.9 Congestion Tone The call attempt is valid but will have to be repeated because of congestion in the switching equipment.
- 3.1.10 Call Waiting Tone An incoming call from the public exchange is waiting attention.
- 3.1.11 PABX Trunk Offering Tone The operator has intruded on the connection.
- 3.1.12 Extension Originated Calls Extensions shall be capable of making internal and outgoing exchange calls according to their classification (see Clause 3.2). Extension originated calls are described in Clauses 3.1.13 to 3.1.20.
- 3.1.13 Seizure A fresh loop on an extension line shall be served with dial tone or, in the case of congestion with a busy signal system, busy tone shall be returned in accordance with Clause 5.2.4. After the application of dial tone the PABX equipment shall be immediately capable of responding to address information signals from the extension line.
- 3.1.14 Address Signals The PABX equipment shall respond to address information signals from the extension lines. The information may be conveyed by:
- sequential decadic pulse signals from dialling devices, or
 - sequential coded VF tone signals from keypads, or
 - sequential coded DC unbalance-to-ground signals from keypads, or
 - in the case of direct access extensions by a signal which conveys the complete address, e.g. via an independent wire from the extension telephone to the PABX equipment.
- 3.1.15 Delayed Address If a fresh loop on an extension line is not followed within between 20 and 100 seconds by the commencement of address information the extension line shall be connected to line lock-out and busy tone shall be returned to the calling loop until it is disconnected.
- 3.1.16 Incomplete Address Incomplete address information, as indicated by a period of between 5 and 20 seconds after the completion of part of the address information shall cause the extension line to be connected to line lock-out and busy tone to be returned to the calling loop until it is disconnected, except for an exchange access call when there is no digit analysis being performed by common equipment at the PABX.

3.1.17 Complete Address Following the receipt of satisfactory address information, and within the post dialling delay standard specified by Clause 5.2.5, the PABX equipment shall return a tone signal to the calling loop as follows:

NU Tone If the address is an unavailable feature, or an unallotted number or a cancelled extension number -

Busy Tone If the address (extension number or all of a group of exchange lines, extension lines, tie lines, assistance circuits or a feature with a common call number) is engaged -

Busy Tone or Congestion Tone If there is no connection path available between the calling loop and the required address -

Ringling Tone If the address is free and a connection path has been established.

3.1.18 Transmission Path A transmission path shall be established between the calling extension line and the called address within 250 milliseconds of the answer signal from the address. It is desirable that extensions equipped with push button telephones be capable of transmitting casual data to the public exchange network during the conversation period in accordance with Clause 9.3.

3.1.19 Release of Internal Calls On an internal call when either party has maintained a clearing signal for between 250 and 500 milliseconds, the connection shall release. The other party shall be connected to line lock-out until a clearing signal is received.

3.1.20 Release of Public Exchange Calls On public exchange calls the PABX connection shall be controlled by the operator or the extension except that first party release will apply on indialled calls (see Clause 9.5.7).

3.2 CLASSIFICATIONS AND INHIBITS

3.2.1 Extension Line Classifications The features available to each extension line shall be determined by the classifications given to that extension within the PABX equipment.

The usual extension classifications and their relationships to the availability of various features are shown in Table 6.

3.2.2 Classification Changes Extension classifications in accordance with Clauses 3.2.3 to 3.2.12 shall be capable of being readily changed without the need to dismantle or disable any equipment or to add components to the equipment. When delivered from the manufacturer all extension lines shall be classified as unallotted numbers (see Clause 3.1.17).

3.2.3 Restricted External Classification When an extension classified as restricted external attempts an outgoing exchange call, an exchange line shall not be selected. The extension shall immediately receive NU tone for between 3 and 7 seconds. If it is not cleared, it will then revert to line lock-out until its loop is disconnected. An extension with this classification is permitted reverted calls, incoming exchange calls, enquiry and automatic transfer.

3.2.4 Denied Classification When an extension classified as denied attempts an outgoing exchange call, an exchange line shall not be selected. The extension shall immediately receive NU tone for between 3 and 7 seconds. If it is not cleared, it will then revert to line lock-out until its loop is disconnected. The operator shall be prevented from connecting a revertive call or incoming exchange call to a denied extension. It will be impossible to transfer an exchange call to a denied extension (see Clause 3.4.4). Enquiry to a denied extension shall be permitted.

An operator attempting to connect an exchange line or an exchange call to a denied extension shall receive NU tone and/or a visual indication at the operators position; NU tone may be transmitted to the exchange line unless the operator divides the circuit.

An indialled call to a denied extension shall receive NU tone. No traffic path through PABX trunking shall be held between either type of exchange line and the extension line in these circumstances.

EXTENSION CLASSIFICATIONS.

Feature	Extension Classification							
	Open	Restricted External	Denied	Trunk Barred	Trunk Route Barred	Executive	Data	Restricted Internal
Internal - originate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes - to selected addresses only
- receive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes - from selected extensions
Assistance - originate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Advice - receive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Incoming Exchange - receive	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Indialled Exchange - receive	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Outgoing Exchange - originate unit fee call	Yes	No	No	Yes	Yes	Yes	Yes	Yes
- originate trunk fee call	Yes	No	No	No	Yes but not on barred routes	Yes	Yes	Yes
- originate trunk fee calls on barred routes	Yes	No	No	No	No	Yes	Yes	Yes
Reverted Exchange - receive	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Enquiry - originate internal local	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes - selected addresses only
Enquiry - originate outgoing exchange	Optional	No	No	Optional but not for trunk fee	Optional but not for trunk fee calls on barred routes	Optional	Optional	Optional
Enquiry - receive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Tie Line - Receive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
- Originate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
- Extended Exchange	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Diverted - receive	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Executive - originate	No	No	No	No	No	Yes	No	No
Priority breakin - originate	No	No	No	No	No	Yes	No	No
Abbreviated code calling	Optional	Optional	Optional	Optional	Optional	Yes	Optional	Optional
Automatic call back - originate	Optional	Optional	Optional	Optional	Optional	Yes	Optional	No
Data - originate	Optional	Optional	Optional	Optional	Optional	Optional	Yes	No
- receive	Optional	Optional	Optional	Optional	Optional	Optional	Yes	No

3.2.5 Trunk Barred Classification An extension classified as trunk barred shall receive NU tone on an outgoing exchange call after dialling the access codes for a network feature such as subscriber trunk dialling (STD), manual trunks or phonograms. Access to the barred network features shall be available on reverted calls, incoming exchange calls and calls transferred from other extensions. Enquiry and transfer on unbarred calls shall be permitted.

The technical arrangement for achieving the trunk barred extension classification shall be as shown in Table 7.

TABLE 7.

TRUNK ACCESS BARRING ARRANGEMENTS.

Type of Parent Exchange to which PABX is connected	Barring Arrangements	Remarks
Step with CE11251 or CE11256 multi-metering	B or C	FTR after trunk access code. Category change signal denotes Non-STD public telephones.
ARF crossbar with Reg LM	A, B or C	FTR after trunk access code.
ARF crossbar with Reg LP	A or C	FTR after 1st impulse train
ARK crossbar	A or C	FTR after seizure.
<p>FTR = Category test signal - fleeting test reversal.</p> <p>A = Exchange performs barring function on receipt of category change signal. See Clause 3.2.6.</p> <p>B = Barring at PABX initiated by category test signal (FTR). See Clause 3.2.7.</p> <p>C = Barring at PABX initiated by address signal analysis. See Clauses 3.2.8 to 3.2.12.</p>		

3.2.6 Trunk Barring at Public Exchange A category test signal (fleeting test reversal) from a crossbar public exchange that is properly answered by a category change signal (see APO Spec. 1105) from the PABX will result in barring at the public exchange of a call to a barred address. NU tone will then be returned from the public exchange until the clearing signal is sent or line lock-out occurs at the public exchange. The category change signal shall only be applied to line at the appropriate time and only if an extension classified as trunk barred is originating the call. It shall not be applied or simulated by exchange line circuit terminating reactances (see Clause 9.2.5) during an operator originated call.

3.2.7 Trunk Barring at PABX With step public exchanges that allow STD access, trunk access shall be barred at the PABX. The step public exchange returns a category test signal (FTR) between 130 and 200 milliseconds after the last pulse of that part of the address signal that indicates the call is to a barred destination. The PABX shall detect the FTR and then before the next part of the address signal can be transmitted to line it shall interrogate the calling extension's classification.

If the call is from an extension not classified as trunk barred, or is from an operator, it shall arrange for the call to proceed normally.

If the call is from a trunk barred extension the PABX shall;

release the exchange line,

return NU tone to the calling extension for from 3 to 7 seconds and then if the release signal has not been received,

release the internal connection through the PABX and revert the call to line lock-out until the loop is disconnected.

3.2.8 Trunk Barring - Address Analysis Address analysis at the PABX to achieve trunk access barring is suitable for use with any type of public exchange. The address signals transmitted to the exchange are to be monitored and analysed to detect a barred address signal being sent from an extension classified as trunk route barred. The PABX operator shall have full access to STD calls. Barring is then provided at the PABX.

3.2.9 Provision shall be made to analyse at least the first four trains of decadic address signals to the public exchange even though for some installations, less than this number may be required.

3.2.10 Following the detection of a barred address code being sent from a trunk route barred extension the PABX shall:

release the exchange line,

release analysis equipment,

return NU tone to the calling extension until the extension release signal is received, or

if the release signal is not received within 5 ± 2 seconds, release the internal connection and revert the extension to line lock-out until the loop is disconnected.

3.2.11 The analysis circuits may be individual to each exchange line or available as common equipment. In the latter case an outgoing exchange call from a trunk route barred extension shall not be able to proceed without the monitoring equipment being connected and operative; the provision of common monitoring circuits shall be such as to satisfy the traffic performance standards specified in Section 5.

3.2.12 The address analysis technique shall prevent fraudulent calls by manipulation or deliberate misoperation of trunk route barred extensions. Address signals must not be acknowledge by the PABX analysis equipment unless they are valid address signals sent to the exchange after dial tone has been received from the exchange. Follow-on trunk access calls from trunk route barred extensions, that may result from differences in circuit release timings between the PABX equipment and the exchange equipment, shall be prevented. A trunk route barred extension shall be prevented from transmitting more than nine pulse trains to the exchange.

3.2.13 Data Calls (Data Access) A data call may be any type of call through the PABX equipment which, because of the terminal equipment connected to the PABX, carries digital information rather than voice transmission. The essential aspect of a data call is that the PABX equipment shall inhibit intrusion to the transmission path of the data call.

Preferably, a call addressed to the data access number shall be identified as a data call; alternatively or additionally the equipment shall identify a special signal transmitted to it from either:

the data source as a prefix or suffix to the address information for the call; or

the data sink following the answer signal.

These special data call signals are not specified. Two tone signal 941/1209 Hz may be used as a prefix before address information signals but shall not be used as a suffix or post-answer signal for this purpose unless it is recommended by the CCITT.

3.2.14 Degrees of Busy and Inhibits The degrees of busy and inhibits are specified in Clauses 13.2.15 to 13.2.19.

3.2.15 The highest degree of busy shall be that assigned to an extension engaged in a data call either as the data source or data sink. No interruption shall be possible.

3.2.16 An extension that is engaged on a call and receives a trunk offering shall not be permitted to originate or receive any other calls during the trunk offering. It shall be possible for the first call to be released so that the extension can connect to the offered call.

- 3.2.17 An extension that is engaged on a call and has an incoming exchange call camped-on shall not be available for any other calls, except for trunk offering. The extension shall be permitted to make an enquiry call without altering this condition.
- 3.2.18 An extension that has been connected to automatic call back shall not be permitted to receive any other calls, except trunk offering, until the automatic call back commences to effect the connection or releases. The extension, if engaged on an exchange call, shall be permitted to make an enquiry call and then have the exchange call return whilst the automatic call back waits on.

When the extension has cleared and the automatic call back is being effected, no other calls to or from the extension shall be permitted until the automatic call back is completed as an internal call or the automatic call back times out without effect. It shall not be possible to have two automatic call back connections to the same extension.

- 3.2.19 Where priority-break-in is provided an extension shall not be permitted to break-in on an exchange connection, a trunk-offer, camp-on, enquiry call or the addressee of an automatic call back.

3.3 OPERATORS POSITION FEATURES

- 3.3.1 Incoming Exchange Call Incoming exchange calls (except indialled) shall signal at the operators position by visual and audible (operator alarm) signals. They shall be answered by the single operation of a key.

To extend an incoming exchange call to an extension, the operator shall either:

- operate a key individual to the extension or
- digit the extension number on a keysender.

When extending an incoming exchange call to an extension the operator shall receive individual and distinctive indication of the following conditions:

The connection has been established and the calling condition has been set up.

The extension has answered the call.

The extension is engaged on another call.

The extension is in line lock-out, or unallotted or denied.

The connection cannot be established because of trunking or switching equipment limitations.

The extension is engaged on another call and a call is already camped-on.

The extension of the call shall be automatic or under the control of a key.

- 3.3.2 Reverted Call The revertive call shall be established on either a bothway exchange line or an outgoing exchange line which is exclusive to one or more operating positions or appears on the operators position but is shared by extensions.

An operator shall be given visual indication of the exchange lines which are available for revertive calls and of their occupancy.

The selection of a free line shall be by the operation of a signal key. It may be selected automatically or individually by the operator. It shall not be possible to select a line that is in use or blocked for service reasons.

The operators circuit shall control the holding, line signalling, and transmission termination of the selected exchange line at this stage. Connection to and restoration from overlapping shall be available as stipulated in Clause 3.3.9.

The call shall be extended to the requiring extension under the same conditions as for an incoming exchange call. After the call has been answered by the extension, the operators circuit shall be released from the connection which shall assume the status of a normal exchange call for transmission and clearing purposes.

3.3.3 Assistance Call

An assistance call shall be catered for by the PABX equipment in accordance with Clause 3.1 except that if the operators positions are switched to night service in accordance with Clause 3.5, the caller shall receive NU tone. A successful call shall light the assistance call lamps on operators positions to indicate that a call from an extension requires service. If there are two or more operating positions, each assistance circuit shall be capable of appearing on at least two positions. An operator will operate a key to answer the call which shall be established in accordance with Clause 3.1 and an engaged indication shall then be given on any other positions, showing that the particular assistance circuit is in use.

If an operator disconnects from an assistance circuit whilst the calling extension is still connected, the extension shall again receive ring tone until the operator re-answers or the extension releases, and at the same time a holding lamp shall light on the operators position on which the call was answered. The call may then be re-answered on any other operators positions on which the assistance circuit appears, in which case the holding signal shall be replaced by the engaged signal on the first position.

The control of the call shall be as follows:

If the call is cleared by the calling extension before answer, the connection shall be released after between 250 and 500 milliseconds and the call lamps extinguished.

If the call is cleared by the extension whilst connected to an operator, the connection shall be released after between 250 and 500 milliseconds, the operator shall be given a distinctive signal and the assistance circuit shall be guarded from access by further traffic until the operator clears the circuit.

If the call is cleared by the extension after the operator has answered and subsequently disconnected from the call, the connection shall be released after between 250 and 500 milliseconds, the supervisory lamp on the operators positions shall be extinguished and the assistance circuit made available for further traffic.

An operator, whilst connected to an assistance circuit, by operating an extension release key shall release the connection and revert the extension to line lock-out. The assistance circuit shall be made available for further traffic after the operator disconnects from it.

3.3.4 Advice Call An advice call shall be established by the operator on either a bothway circuit which is also used to receive assistance calls (see Clause 3.3.3) or an outgoing circuit connected to the operators position specifically for calls to extensions.

In either circumstance the circuit shall be key controlled, and visual indication of occupancy shall be provided.

Address signals to the extension shall be by either:

direct individual key or

keysender operation

Indication of the condition of the call shall be the same as for extension of incoming exchange calls. See Clause 3.3.1.

3.3.5 Trunk Offering It shall not be possible for more than one operator to simultaneously trunk offer calls to the same extension. During trunk offering, transmission is allowed between the operator and both parties of the call on which the required extension is engaged; all parties shall be warned of the condition by the trunk offer tone (see Clause 3.1.11). The offered call shall be connected if the extension is released from the initial call during trunk offering subject to the division of the circuit in accordance with Clause 3.3.8. Trunk offer shall take priority over camp-on-busy and call waiting feature connections.

3.3.6 Camp-on-busy After addressing an incoming exchange call to a busy extension, the next operating function, or the release of the call from the operators circuit will cause the call to camp-on the busy extension. When the extension becomes idle, continuous ringing current shall be applied for 0.4 seconds. This shall be followed by interrupted ringing current and the camped-on call shall be connected without further operator action. During camp-on-busy, call waiting tone shall be applied to the busy extension, and no tone shall be heard by the caller. Supervisory indications shall permit the operators to follow the condition of the camped-on call. Only one incoming exchange call may be camped-on an extension at a time. If the busy extension is classified as denied or has a call waiting connection, camp-on-busy will be prevented and an indication will be given to the operator who shall remain connected to the incoming exchange call.

3.3.7 Automatic Operator Recall Automatic operator recall shall signal the operators position to indicate that:

an incoming or revertive exchange call which has been set up, or camped-on, has not been answered by the extension within between 30 and 45 seconds,

or a previously answered call which has not been extended has been waiting for a similar period while other functions of the operators position have been proceeding.

The signal indicating automatic operator recall shall be different from that indicating an enquiry call to the operators position. The operator shall gain access to the connection by the operation of a key on the position and shall again control the call, but if the extension answers before the connection is released by the operator the call shall proceed normally.

3.3.8 Divided Working While either party is held on a divided connection they shall not be able to hear or be heard by the other party. The divided connection shall be under the control of keys on the operators position and may be arranged so that the operator can hear the held party while conversing with the other.

3.3.9 Overlapping Overlapping shall preferably be established by the single operation of a key. Only one overlapped connection shall be permitted for each operators position. Audible information on the overlapped call shall be heard by the operator but not by any other call. The exchange party on overlapping shall not hear any PABX conversation, nor the operator, nor tone from the PABX. Restoration of the overlapped call to normal shall be by the single operation of a key. Visual indication shall be given of the feature and the exchange line on which it is established.

3.3.10 Serial Call This feature shall be applied by the single operation of a key. Generally the call shall be extended in the normal manner and the normal conditions and restrictions of an incoming exchange call shall apply, but when the extension to which the call is connected clears the call shall be held and resignalled with a distinctive recall indication to the position where it was originally answered. The exchange call shall only be cleared from the PABX after the single operation or restoration of a key.

3.4 EXTENSION FEATURES

3.4.1 Enquiry Call An enquiry call shall be available to any extension on all incoming exchange calls including indialled and may be available on outgoing exchange calls. Normally it will be provided only for internal calls, but if exchange access from enquiry is provided, the extensions normal classification shall still apply, extensions classified as restricted external or denied, must not gain access.

3.4.2 Establishing an Enquiry Call The enquiry shall be initiated by the single operation of a non-locking enquiry button on the extension telephone. The signal generated by this action, shall not be transmitted to the exchange line. At the completion of this signal, the PABX equipment shall hold the exchange line and connect the extension to a fresh loop, so that it shall receive dial tone and proceed as follows:

Internal Enquiry If the enquiry call is to an internal extension the procedure and switching after receiving dial tone is the same as for an internal call.

Operator Enquiry If the enquiry call is to the operator, it shall not involve an assistance circuit, but shall signal the enquiry on the exchange line circuit on the operators position on which the incoming call was established. The calling extension shall receive ringing tone. The operator may answer the enquiry by operating the answer key for the particular exchange line.

Exchange Enquiry Where exchange access from enquiry is available the procedure is the same as that for an outgoing exchange call when dial tone has been received.

3.4.3 Release of Enquiry Call To re-connect to the exchange call, the extension shall re-operate the enquiry button and be returned to the exchange call within 100 milliseconds.

If the extension making the enquiry clears before the called party answers, the enquiry connection shall be released, and the extension shall be re-rung and connected to the exchange call under the same conditions as for incoming exchange calls.

There shall be no limit to the number of enquiry calls that an extension can make on any exchange call except that at the completion of each enquiry the extension shall re-connect to the exchange call before making a further enquiry call.

On an enquiry call to the operator, if the operator disconnects whilst the calling extension is still connected, the connection shall remain and the enquiry signalling conditions to the operator and extension shall be re-applied.

3.4.4 Automatic Transfer This feature shall be available on incoming exchange calls and may be available on outgoing exchange calls. It shall be possible to transfer calls to the operator or any extension, except those classified as denied.

Action to initiate the automatic transfer shall be the same as in Clause 3.4.2 for an enquiry call.

Except in the case of small PABXs without an operators position (see Clause 3.8.2) the actual transfer shall not be effected before the called extension answers and may then be completed by either:

If the called extension holds when the calling extension clears from the enquiry call, the exchange call shall be connected to the called extension within between 250 and 500 milliseconds. This extension shall then control the call. If the called extension is classified as denied or the transfer cannot be effected for any other reason, the enquiry call shall be cleared and the calling extension shall be re-rung and re-connected to the exchange call. The denied extension shall be connected to line lock-out.

The operation of the enquiry button by the called extension shall within between 250 and 500 milliseconds, disconnect that extension from the enquiry call and connect it to the exchange call. The calling extension shall be connected to line lock-out. If the called extension is classified as denied or the transfer cannot be effected for any other reason, the enquiry condition shall remain unaltered. The calling extension shall re-operate the enquiry button to disconnect the enquiry call and shall be re-connected to the exchange call. The denied extension shall be connected to line lock-out.

3.4.5 Transfer to the Operator An exchange call shall be transferred to the operators position after the enquiry call has been established by either:

If the extension clears whilst connected to the operator, the enquiry connection shall release and the operator shall within between 250 and 500 milliseconds be connected to the exchange line. This shall be automatic without the need for any further

operator action, but the operator shall be given a distinctive visual signal. The exchange call shall be held and controlled from the operators position in the same way as an incoming exchange call.

The operator whilst connected to the enquiry call may, by operating an extension release key, release the enquiry call and shall then be connected to the exchange line within between 250 and 500 milliseconds. The extension shall be disconnected from the enquiry condition and shall be connected to line lock-out.

3.4.6 Automatic Call Back When busy tone is received by the calling extension, the caller may dial a special code to establish connection to the automatic call back circuit. If there is an automatic call back circuit free and the called extension does not have an incoming exchange call, camped-on, in call waiting, or being trunk offered or does not have an established priority break-in or another automatic call back, busy tone shall be disconnected from the calling extension to indicate that connection has been established to the automatic call back circuit. The calling extension may then clear and may proceed to make or receive calls. When the called extension becomes idle, providing it does so within 6 to 9 minutes of the automatic call back being established, the following conditions shall apply:

Calling Extension Idle The calling extension shall be rung and when it is answered the called extension shall be rung; ringing tone shall be fed to the calling extension.

Calling Extension Busy Call waiting tone shall be injected into the calling extension connection. If the calling extension becomes idle within 15 to 25 seconds the extension shall be rung and when it is answered the called extension shall be rung; ringing tone shall be fed to the calling extension.

The connection to the automatic call back circuit shall release if the called extension remains busy for 6 to 9 minutes after it has been established or if the calling extension remains busy for 15 to 25 seconds after receiving call waiting tone or does not answer the call back within that time.

The called extension shall be prevented from originating or receiving other calls until the automatic call back has been effected or the connection clears as above. If the called extension attempts to originate a call while the automatic call back feature is connected, call waiting tone shall be fed to the extension.

The connection shall be provided independent of the automatic call back circuit through normal trunking and the call back circuit shall clear.

Full utilisation of the automatic call back feature shall not degrade the service of any traffic classification or traffic route by more than 10 per cent.

3.4.7 Individual Diversion This feature shall be programmed in the PABX equipment and a timing device shall introduce the feature if calls to an extension are not answered within 9 to 12 seconds. Both extensions shall then ring simultaneously. Where the call is answered by the second extension it shall be possible to take over the call at the address extension and the conversation shall then be secret from the second extension.

3.4.8 Group Search This feature shall apply to terminating internal calls, operator extended calls, tie line calls or indialled exchange calls. The address code may be an extension line number or a single or multiple digit special number (see Clauses 5.3.2 and 3.6.2) but calls shall be offered to any one of several extensions. The number of extensions served by the group search feature may vary between a minimum of five and a maximum of twenty in any one group and the number of groups available shall not be less than 2 per cent of the extension line capacity of the PABX type. The extensions in any group shall be capable of being flexibly distributed over various trunk allocations in the line finder or primary switches so as to equalise the traffic load.

Selection of extensions in a group shall preferably be fixed start sequential search although other selection orders may be approved. The individual extensions shall be available to their own extension address signals. They shall also be capable of individual classification options and normal traffic features shall apply.

3.4.9 Extension Number Translator An easily manipulated strapping or jumpering field or frame shall be associated with the extension number translator to permit full flexibility in the allocation of directory addresses to the first switching stage (equipment address).

3.4.10 Abbreviated Code Calling An extension provided with this feature shall have access to a store of abbreviated code addresses. The action to change the codes in the store shall be simple and preferably under the control of the extension.

3.4.11 Direct Access Extensions may be equipped with keyset units that permit the extension to address a number of extensions by single key operations. Units shall conform to APO Specification 1053 and other relevant APO specifications.

3.4.12 Conference Call Three or more parties may participate in a multi-way conversation. Conference features may be allowed or denied exchange access. If exchange access is allowed the specifications of interface with the public exchange network shall apply (see Sections 8 and 9).

Exchange lines shall not be interconnected - (see Clause 3.1.2).

Provision shall be made to limit the number of conference parties so that the technical stipulations of this specification continue to apply. Manual transmission level controls for use by the operator or conference parties shall not be permitted.

The conference establishment and breakdown procedures and functions shall be simple and logical and shall be conducted individually by the conference parties or by the operator or a conference controller. The use of a conference feature shall not impede any other feature or function of the PABX and shall not result in the grade of service of any traffic classification or traffic route being worsened by more than 10 per cent (see Clauses 5.2.1 and 5.2.5).

3.4.13 Manual Conference Call shall be established under the same conditions and limitations as the conference call (see Clause 3.4.12) except that the call shall be set up and taken down by the operator who may be one of the conferees.

3.4.14 Add On Enquiry shall be subject to the conditions and limitations of a conference call (see Clause 3.4.12). The extension controlling the exchange line call shall control the add on enquiry. In PABXs which provide exchange access on enquiry calls, add on enquiry shall not be permitted if the enquiry is through the public exchange.

3.4.15 Power Fail Transfer This feature shall be provided for all PABXs other than those powered from secondary batteries (see Section 11). During a power failure all incoming and bothway exchange lines and as many outgoing exchange lines as may be required by the customer, shall be connected to individual extensions. Incoming or outgoing exchange calls in progress during power failure shall not be disconnected or lost as a result of partial or full restoration of power. Removal of the exchange line circuit from the equipment shall not result in loss of service by the extension.

3.5 NIGHTSERVICE

3.5.1 General This feature shall be effected by each of the following:

The operation of a nightservice key or control on the operators position.

Automatically for the line concerned, if an incoming exchange call remains unanswered for between 45 and 60 seconds and each of the operators position is:

unstaffed due to the operation of a "non-staffed" key or has the operators telephone set jacks vacant or,

does not have any other exchange line function key operated in that time.

If the operators position is not provide (sub-attended PABX operation), or is removed for maintenance attention.

3.5.2 Incoming calls shall not be falsely answered, disconnected, or lost due to the operation or restoration of nightservice.

3.5.3 If a nightservice incoming exchange call is cleared from the exchange before answer at the PABX, the PABX equipment shall clear so as to receive a follow-on incoming exchange call.

3.5.4 Extensions receiving nightservice exchange calls shall have "enquiry" and "automatic transfer" features.

3.5.5 Basic Categories Nightservice shall be provided in two basic categories:

for calls addressed to the directory number of an exchange line group or

for calls addressed to individual lines within an exchange line group or to single exchange lines.

3.5.6 Nightservice for Calls to Directory Number Nightservice for calls addressed to exchange line groups shall be further subdivided into the categories described in Clauses 3.5.7 to 3.5.10.

3.5.7 Remote Alarm Nightservice Incoming exchange calls addressed to the directory number shall be automatically connected to a system of alarms (design minimum of five). An access code to answer the call (see Clauses 5.3.2 and 5.3.3) may be addressed from any extension except those classified as denied. The answering extension shall control the call and the equipment will prevent more than one extension receiving each incoming exchange call. If subsequent incoming exchange calls arrive before an incoming call is answered there shall be a distinct pause in the bell ringing as the previous call is answered. When there are several unanswered calls it shall be possible for these to be answered coincidentally by any idle extensions except those classified denied. It is preferred that the calls be answered in order of arrival.

3.5.8 Selected Nightservice Incoming calls addressed to the directory number shall be automatically connected to a preselected extension. Any extension not classified as denied may be preselected. The first incoming call to arrive when the preselected extension is engaged shall camp-on-busy. Subsequent incoming calls shall not camp-on-busy until the previous incoming call has been answered and then shall be offered for camp-on-busy or connection one at a time.

3.5.9 Doctor's Nightservice The arrangement shall be the same as for selected nightservice, except that the selection of the nightservice extension shall be controlled from the operators position. A number of extensions shall be available for pre-selection at the operators position which shall be designed to cater for a minimum of 5 nightservice extension alternatives. A visual indication shall be given at the operators position of the extension number selected for nightservice.

3.5.10 Group Nightservice This category of nightservice shall be established in a similar manner and under the same conditions and limitations as selected nightservice except that the preselected extension shall be the group call number of a group of extensions in a group search configuration (see Clause 3.4.8). When all extensions in the group are engaged, further incoming calls shall be stored. Following the release of an extension in the group, a waiting incoming call shall be selected from the store, preferably in order of arrival, and be connected to that extension.

3.5.11 Nightservice for Calls to Individual Exchange Lines Nightservice for calls addressed to individual exchange lines shall be catered for by individual nightservice as described in Clause 3.5.12.

3.5.12 Individual Nightservice This category of nightservice shall be established under the same conditions and limitations laid down for selected nightservice (Clause 3.5.8) except that each exchange line shall be directed to a particular extension so that only that extension will receive incoming calls on that line. If the extension is engaged and an incoming exchange call is received on that line it shall camp-on-busy.

3.5.13 Combined Nightservice This category of nightservice shall provide for a combination of any two or more types of nightservice.

3.6 INDIALLING

3.6.1 General Calls dialled directly from the public exchange network shall not be served with dial tone on seizure of the PABX exchange line. Indialled calls to extensions classified as denied or unallotted extension numbers, or unequipped number levels shall receive NU tone from the PABX. Indialled calls shall, if the addressed extension is free, receive ring tone from the PABX until the call clears, or the extension answers. If the extension is engaged, the call shall receive busy tone from the PABX.

3.6.2 Number Length The number length of indialled calls into the PABX, including the operators number where available, shall be uniform for any group of indial lines and the same as for calls to non-PABX subscribers connected to the same public exchange. The number of digits required for switching within the PABX shall be as short as possible.

3.6.3 Options The PABX equipment, shall provide the following indialling options:

One group of lines for all extension numbers and access to the operator.

One group of lines for all extension numbers and excluding access to the operator.

Separate groups of lines for each 1000 or 100 group of extension numbers.

Translation of the first indialled digit so that the network numbering spectrum may be fully utilised whilst the PABX users retain closed numbering in accordance with Clause 5.3.2.

3.6.4 Unanswered Calls Indialled calls that are unanswered after between 30 and 45 seconds may signal to the operators position as well as to the addressed extension. Whichever of the extension or operator answers first shall receive the call and disconnect the other party; in the event of simultaneous answer priority shall be given to the extension.

3.6.5 Inhibits Indialled calls shall not be connected to the operator or any extension line for any of the conditions specified for NU tone in Clause 3.6.1 nor for any malfunctioning or underprovision of the PABX equipment.

3.6.6 Line Signalling Details of line signalling and release conditions for indialled calls are given in Clauses 3.1.20 and 9.5.7.

3.7 ADDRESS RECORDING AND METERING

3.7.1 Call Address Recording Call address recording equipment shall record some, or all, of the following information about calls on outgoing exchange lines:

The originating address (extension or operator).

The address called.

The time and date that the call was placed.

Whether the call was answered or abandoned before answer.

The call duration.

The number of meter pulses for the call.

The equipment shall be an attachment to the PABX exchange line and extension line connections and shall not affect the transmission and signalling performance of these circuits. The call recording printer, timer and associated control circuitry shall conform to APO specifications (e.g. APO Specification 1053), but may be such that the APO may elect not to maintain all or part of it. It would then be located remotely from the PABX equipment in accordance with APO Specification 1071.

As a minimum requirement the call address recording equipment shall provide the same features as the APO PETRA - Call Analyser details of which are contained in APO (Interim) Engineering Instruction TELEPHONES, Substation Z0006.

3.7.2 Call Metering If call metering is available meters or other readout devices shall be rack mounted away from the equipment. Each meter must be identifiable with its extension, or exchange line. Resettable meters may be provided on or near the operators position for metering individual reverted calls. Each meter shall be dedicated to a revertive exchange line.

Meter pulse signals sent from the public exchange as specified in APO Specification 1105 shall be used. The meter pulse detection circuitry shall only be exposed to the exchange line after the completion of address signalling and shall be removed before the clearing signal is sent from the PABX. It shall operate on 1mA with a recognition time of 20 milliseconds minimum to 100 milliseconds maximum and be insensitive to ringing current and spurious signals such as transients due to other signals or low level 50 Hz induction from other lines. It shall not operate to a current of 0.25mA. The total pulse detection current shall decrease by 20% for variations of signal frequency of 1.5 Hz either side of 50 Hz.

3.8 PABXs WITHOUT OPERATORS POSITION

3.8.1 In the case of systems provided without an operators position, consideration may be given to alternative feature techniques to facilitate traffic handling. The features and acceptable alternative techniques are outlined in Clauses 3.8.2 to 3.8.4.

3.8.2 Automatic Transfer The transfer shall be set up in accordance with Clause 3.4.4. When the transferring extension receives ringing tone it may clear without waiting for an answer. In the event of the called extension not answering within between 30 and 45 seconds the transferring extension shall be re-rung and the call shall be re-connected on answer.

3.8.3 Incoming Exchange Call If an answering extension is not able to extend an incoming exchange call, a holding or parking feature must be provided so that the call may be parked while another call is answered.

The parked call shall not overhear conversation on any other call.

The parked call shall be retrievable and shall automatically recall to the answering extension within between 30 and 45 seconds.

3.8.4 Outgoing Exchange Call The selection of an exchange line for outgoing calls by an extension classified as open may be by the operation of an enquiry button.

4.1 CONSTRUCTION

- 4.1.1 Operators positions to provide the various operational requirements of Feature List D shall be cordless types.
- 4.1.2 The shape, dimensions and layout of operators positions shall be planned for functional performance and maintainability. Regular maintenance shall be possible whilst the operator continues to use the position.
- 4.1.3 The materials and construction techniques employed for operators positions shall be in accordance with Section 6 of this specification. The positions shall withstand constant use for the life of the equipment without unsightly deterioration. Surfaces shall be non-reflective.
- 4.1.4 The operators positions may be free standing or table mounted although the latter is preferred. Table mounted designs shall be provided with the following features:

At least four-non-slip feet generally in accordance with APO Specification 1041.

A flexible cord with plug and socket for wall mounting. The plug shall be identical with the operators position cable connection plug used at the switching equipment, so that the position may be taken to and used at the equipment. The free length of the flexible cord shall be between 1800 millimetres (6 feet) and 2400 millimetres (8 feet).

4.2 SWITCHING FEATURES

- 4.2.1 Incoming Lines - Direct Appearance PABXs having a total capacity of 15 or more incoming or bothway exchange lines shall be capable of providing for two or more operators and shall have the features specified in Clauses 4.2.2 to 4.2.5.
- 4.2.2 Each direct appearance line shall be capable of being multiplied over at least two positions.
- 4.2.3 Re-distribution arrangements via an IDF, to vary traffic loadings to positions and associated trunking shall be provided.
- 4.2.4 Position coupling shall enable an operators circuit to be employed on an adjacent position. Removal of the handset plug from the vacated operators position shall initiate position coupling.
- 4.2.5 For a particular call, subsequent access and signalling shall be available only to the position on which the call was initially answered.
- 4.2.6 Incoming Lines - Link Appearance Incoming exchange lines and other circuits to the operators positions shall preferably appear directly on the positions. Where connecting link appearances are used the conditions of Clauses 3.3 and 4.2.7 to 4.2.12 shall be met.
- 4.2.7 Call distribution shall be used, the calls being offered only to staffed positions where the operator is not engaged on a call. Calls shall be allocated in order of arrival and shall be distributed to operators positions in a random order to ensure equitable loading.
- 4.2.8 At least one link on each position shall be available for automatic operator recalls. Preferably the operator who extended the call shall be ressignalled.
- 4.2.9 Provision shall be made to identify the group of lines to which the calling line is connected, should more than one group of lines be connected.
- 4.2.10 A lamp display shall be provided to continuously monitor the condition of the incoming exchange lines.
- 4.2.11 It shall be possible to identify the exchange line connected to any link at any time.
- 4.2.12 Links shall only be used for access to or from the operator.
- 4.2.13 Advice/Assistance Circuits A minimum of 2 circuits for advice and assistance calls shall be provided on each operators position (see Clauses 5.2.1 and 5.2.8).

4.2.14 Operator Restriction of Access There shall be visual indication on the operators position of the operation of the feature. It may be incorporated with the nightservice feature. Extensions classified as executive may retain their normal classification.

4.3 COMPONENTS

4.3.1 Manual Controls The manual controls of operating positions shall be lever or pushbutton keys. In the latter case an illuminated pushbutton key may be used. All key units shall be readily accessible and shall be easily replaced.

4.3.2 Lamps If lamps are used for signalling, they shall be easily replaceable without the use of tools other than a simple lamp extractor. Failure of a call lamp shall be shown by the operation of a separate pilot indicator.

4.3.3 Dial A dial (see Clause 7.3.14) or other approved device, shall be provided on each operators position that may be required to send decadic address information signals to the public exchange. Duplicate dials with changeover facilities may be provided. The dial shall be located for operation by a right-handed operator. The dial mounting shall allow easy replacement of the dial in accordance with Clause 4.1.2. The electrical connections to the dial shall employ easily replaceable connectors (e.g. quick connect tags in accordance with APO Specification 1039).

4.3.4 Keysenders Keysenders may be provided instead of dials. For pushbutton senders the disposition of the keys shall conform to recommendation E161 of volume IIA of the CCITT White Book. Keysenders shall be easily replaced.

4.3.5 Operators Telephone This shall be either:

a handset see Clause 7.3.14, or

an APO standard headset which will be provided by the APO.

The transmission performance of the operators telephone circuit shall meet the requirements of Clause 8.3.3. The headset or handset flexible cord shall be connected to the position with a standard APO headset plug and socket. Two sockets shall be provided for each position.

4.4 DISPLAYS

4.4.1 Each display may contain a variety of devices depending on the individual installation requirement.

4.4.2 Busy Extension Display Preferably, for each extension line, a lamp will light in the display when the extension is engaged on a call or is in line lock-out. The lamps shall be arranged numerically and designated. The display shall be switched on or off from the operators position.

4.4.3 Extension Number Display Preferably, in the case of operators positions having direct extension selection, a lamp associated with each extension key will flash. For single operating position systems the extension number display may be the flashing of a lamp in a busy extension display. For other cases the extension number display should consist of an array of numeric indicators.

4.4.4 Extension Status Display shall provide visible indication of an extension's classification and state of occupancy when the operator is connected to the extension circuit. It may be incorporated in the busy extension display. The display shall preferably be actuated automatically but may be switched on or off from the operators position.

4.4.5 Call Count Display may be provided by any type of easily read counting device.

4.5 MISCELLANEOUS

4.5.1 Operator Alarm Audible alarms shall be provided with a readily adjustable loudness and cut-off control. With the loudness at its minimum setting, the alarm shall still be audible.

4.5.2 Designations Exposed designations on the manual switchboard shall be engraved and filled with material of a contrasting colour. Operational designations shall be provided for:

sequential identification of all lines terminating on the operators position, the function names, or APO standard abbreviations for keys and lamps, the function names, or APO standard abbreviations for control and indicating devices on other apparatus used by the operator.

4.5.3 Resistance Limits. The single wire resistance limit between PABX switching equipment and operators positions shall be at least 100 ohms.

4.5.4 Blind Operator Aids shall provide indication of calls to enable a blind person to operate the position. Tones shall identify the category of the calling signal and its location. A control shall be provided to enable the operator to adjust the volume of the tones. A light sensing probe with adjustable sensitivity shall identify the signal. The probe shall be connected to the operators position by a flexible cord with a plug and socket. Tactile indicators may supplement tones.

The provision of blind operator aids shall not affect the operation of the position by a sighted operator.

**SECTION 5 - TRUNKING GRADES OF
SERVICE AND NUMBERING**

5.1 TRUNKING - GENERAL

- 5.1.1 With due regard to economics, full availability trunking should be used; full access is essential for switching incoming exchange lines and tie lines to extensions.
- 5.1.2 Where limited availability trunking is employed, facilities to interconnecting outlets to outgoing trunks, and to balance and mix incoming trunk groups shall be provided. Whenever possible, homogeneous or pseudo-homogeneous interconnection schemes shall be used.
- 5.1.3 The PABX shall operate as a busy signal system with respect to automatically selected speech circuits. Delay service is permitted on circuits served by the operator, and on common control circuits used solely for signalling, switching and other control functions.

5.2 GRADES OF SERVICE

- 5.2.1 The average overall busy hour grade of service required after local dial tone is one lost call in 100. That is, the average probability of not being able to switch a call (after receiving local dial tone) because of traffic congestion in the PABX or exchange lines shall not exceed 0.01. This grade of service applies to the following types of calls.

Internal (See Clause 2.2.63).

Incoming, from public exchange to extensions via the operator, (see also Clause 5.2.6).

Outgoing, from extensions to exchange (automatic access).

Outgoing, from operators positions, but reverted to extensions, which have no direct automatic access to exchange lines.

Assistance.

The grade of service for other types of calls is specified in Clauses 5.2.2 and 5.2.3.

- 5.2.2 The average overall busy hour grade of service from exchange to extension on indialled calls shall be 12 lost calls in 1000, or better; that is, the average congestion probability shall not exceed 0.012. The above grade of service includes a maximum probability of 0.002 of losing or misdirecting an indialled call because the common control equipment is not ready to receive the digits of the extension number.

- 5.2.3 Different grades of service (designated B) shall apply to the following types of calls:

Enquiry, while holding an exchange line; - $B \leq 0.012$

Outgoing to exchange from operators position and reverted to extensions which have direct access to exchange lines; - $B \leq 0.02$

Outgoing to another PBX or PABX via tie lines; - $B \leq 0.1$

Incoming from another PBX or PABX via tie lines; - $B \leq 0.1$

It is assumed that for tie line calls, alternative access via the public network is possible. If this is not so, the design grade of service shall not exceed 0.02.

- 5.2.4 The probability of a call being blocked before local dial tone is provided shall not exceed 0.005. Also, the probability of a dial tone or busy tone connection being delayed more than two seconds after lifting the receiver shall not exceed 0.01.
- 5.2.5 The probability of post-dialling delay greater than two seconds shall not exceed 0.01.
- 5.2.6 In a PABX provided with a manual operator, the probability of not answering a call to the operator within 20 seconds shall not exceed 0.05. This standard shall apply regardless of the method used for operator access and shall include any delays introduced by the access circuit. The delay is the period between the connection of ring tone to the calling line and the operator answering the call.

5.2.7 The congestion losses may be distributed arbitrarily between selection stages, and between internal congestion and exchange line congestion, provided that the overall design loss probability on any type of call does not exceed the standards specified in Clauses 5.2.1 to 5.2.5.

5.2.8 PABXs provided with an operators position shall provide a minimum of 2 circuits for advice and assistance calls.

5.2.9 The range of PABXs shall be able to handle at least the range of traffic situations shown in Table 8 at the grades of service specified in Clauses 5.2.1 to 5.2.5. Table 8 shows the distribution of time consistent busy hour traffic rates per extension line (originating plus terminating) for typical PABX installations in Australia.

TABLE 8

PABX INSTALLATIONS - TIME CONSISTENT BUSY HOUR TRAFFIC

Total Erlangs/Extn.	Extension Lines Connected in the Range					
	51-90	91-150	151-250	251-400	401-800	>800
> 0.3 Erlangs	1	-	-	-	-	-
0.275-0.300	1	2	2	-	-	-
0.250-0.275	2	-	-	-	-	-
0.225-0.250	3	-	1	3	-	-
0.200-0.225	3	3	5	1	-	-
0.175-0.200	11	6	2	-	1	-
0.150-0.175	12	13	7	1	1	3
0.125-0.150	11	14	8	4	2	1
0.100-0.125	19	20	6	8	-	1
0.075-0.100	10	5	6	2	4	1
0.050-0.075	5	6	1	1	1	1
0.025-0.050	1	1	2	-	-	-
< 0.025 Erlangs	-	-	-	-	-	-
Number of PABXs in sample	79	70	40	20	9	7

5.2.10 The mean holding time of PABX calls varies from installation to installation. The following average holding times shall be assumed: 140 seconds for external calls (via public exchange or tie lines), 60 seconds for internal calls and 20 seconds for assistance calls. The holding time for exchange calls via the operator does not include operator service time prior to establishing the exchange to extension connection. The mean operator service time may be assumed to be 18 seconds with the distribution of the service time following a negative exponential model.

Revertive calls may be assumed to have a total holding time of 160 seconds, 50 seconds of which is operator holding time.

5.2.11 For the dimensioning of common control equipment a dial speed of 10 pulses/second, shall be assumed. The average interdigital pause is 1.2 seconds. On indialled calls, 150 mSecs may be assumed available for the connection of an incoming register (or equivalent equipment) to the exchange line.

5.2.12 The APO does not usually estimate the internal traffic for PABXs of approximately 50 extension lines capacity or less. PABXs in this range are termed small fixed dimension PABXs and shall conform to the minimum requirement of Table 9. This table assumes full availability trunking.

TABLE 9

SMALL FIXED DIMENSION PABX CAPACITIES

Capacity - Extension Lines	Minimum Requirements		
	Bothway Exchange Lines	Local Connecting Circuits	Registers
4	2	1	1
5	2	2	1
6 to 8	3	2	1
9 to 10	3	2	2
11 to 15	4	3	2
16 to 19	5	3	2
20	5	4	2
21 to 26	6	4	2
27 to 31	7	4	2
32 to 33	7	5	2
34 to 41	8	5	2
42 to 49	9	6	2
50	10	6	2

5.3 NUMBERING

5.3.1 The PABX numbering scheme shall follow a logical decadic scheme. Extension number translators that disassociate the number from the equipment allocation, shall be provided for heavy traffic requirements and may be used for fixed number installations, such as hotels.

5.3.2 The number length of a system shall be as short as possible consistent with the capacity of the PABX and shall provide flexible numbering allocations within the plan shown by Table 10 except as indicated in Clause 5.3.3.

TABLE 10

NUMBERING PLAN AND ACCESS CODES

Call Type	PABX Numbering Range		
	2 Digit	3 Digit	4 Digit
Access to extensions (A)	NX, MX, (9N, 9M, 99, 90)*	NXX, MXX, (9NX, 9MX, 99X, 90X)*	NXXX, MXXX
Access to O.G. exchange lines	0	0	0
Assistance calls	9, (91)*	9, (91)*	9
Access to tie lines	M, A	M, MX, A	M, MX, MXX, A
Access to special features	M, A	M, MX, A	M, MX, MXX, A
Answer remote alarm nightservice calls. (See Clause 5.3.3)	1	1	1
N = 2 to 4 inclusive, M = 5 to 8 inclusive, X = 1 to 0 inclusive, A = extension number			

* The numbers in brackets apply when code 91 is used for operator access.

5.3.3 When address signals within the PABX are generated exclusively by push-buttons, N in Table 10 may be 1 to 4 inclusive. If 1 is used as the first digit of the address information, code 9 shall be allocated to answer remote alarm nightservice calls during periods of full nightservice.

SECTION 6 - PHYSICAL DESIGN OF EQUIPMENT

6.1 GENERAL

- 6.1.1 The equipment shall be readily installed and maintained in accommodation specified in Specification 1071 with the exception that it must be able to be readily installed and maintained in a room with clear ceiling height of 2440 millimetre (8 feet). Consideration may be given to systems of greater than 1000 extension line capacity which require a ceiling height greater than 2440 millimetre (8 feet).
- 6.1.2 Equipment proposed for installation in general office space should not exceed 2130 millimetre (7 feet) in height and should be mounted in enclosed cabinets or frames. A physical appearance in keeping with modern office furnishings is also required. The noise generated should not cause disturbance in a normal office environment.
- 6.1.3 Equipment to meet Feature Lists AL and BL shall be designed for installation in general office space; equipment to meet Feature Lists AU and BU may be designed for installation in general office space.
- 6.1.4 The equipment when crated and mounted on a dolly shall be able to pass through a nominal 810 millimetre (2 feet 8 inch) by 2030 millimetre (6 feet 8 inch) doorway and be moved through normal passageways.
- 6.1.5 The weight of a fully equipped rack or frame relative to its base area shall not exceed 1220 kilogram per square metre (250 pounds per square foot).
- 6.1.6 The distributed floor load of a complete installation, including batteries where required, shall not exceed 244 kilogram per square metre (50 pounds per square foot).
- 6.1.7 The equipment housing shall provide protection from dust, moisture and other foreign matter. The equipment shall be protected from mechanical damage and from unauthorised interference if it is intended for installation in general office space.
- 6.1.8 Frames, racks or panels shall not distort during normal transport, installation and maintenance activities.
- 6.1.9 The centre of gravity in the vertical plane of a full or normally partially equipped rack or frame shall be located not more than one third of the height from the base. In the horizontal plane the centre of gravity of a full or normally partially equipped rack or frame shall be not closer to any edge than one third of the overall rack or frame dimension in that direction at the base of the frame.
- 6.1.10 Facilities shall be available for each frame and row of frames to be levelled to compensate for floor irregularities of up to 15 millimetres per metre ($\frac{1}{2}$ inch in 3 feet) in any direction.
- 6.1.11 Each interchangeable device shall be provided with lifting and handling aids and shall be mounted in the equipment with its lower lifting support in accordance with the following:
- 12 kilograms (26 pounds) or more weight - not more than 1370 millimetre (54 inches) from the floor.
 - 18 to 40 kilograms (40 to 90 pounds) weight - not more than 910 millimetre (36 inches) from the floor.
 - More than 40 kilogram (90 pounds) weight shall not be acceptable as an interchangeable device.
- 6.1.12 Strapping fields on the frame which controls classification options shall be located within the height range of 760 millimetres (2 feet 6 inches) and 1520 millimetre (5 feet) from the floor.
- 6.1.13 Devices that require inspection or adjustment insitu shall be located at least 250 millimetre (10 inches) above the floor level.
- 6.1.14 Access for maintenance whilst the equipment is active shall be provided for all devices, components and terminations mounted on or within each frame.
- 6.1.15 Inter-frame and intra-frame wiring, and TCF jumpering facilities shall be enclosed.

- 6.1.16 The equipment frame connector for cabling to a table mounted operators position shall be the same as the wall connector used for the cable at the operating location (see also Clause 4.1.4).
- 6.1.17 Earth connections to meet the requirements of APO Specification 1071 shall be provided in accordance with Clauses 6.1.18 to 6.1.22.
- 6.1.18 The frame earthing bolt and nut shall be brass with a bolt diameter of not less than 6 millimetre ($\frac{1}{4}$ inch).
- 6.1.19 Exposed metal parts of panel assemblies and sub-assemblies shall be connected to the adjacent metal framework by nibs pressed into the metallic structure or by plated screws fitted with plated "star" washers. Where screwed earth connections are used, an earth lug shall not be placed under a screw holding any other component or sub-assembly.
- 6.1.20 All earth circuits, such as low voltage power earths, ringer earth, tone or signal earths, control earths, screen earths, except electrical supply mains frame earth, shall be connected to the same earth system without fusing or other overload disconnection device.
- 6.1.21 The electrical supply conversion equipment shall be provided with a separate earth system to comply with SAA Wiring Rules AS CCl.
- 6.1.22 Earth conductors, connected to the main earth system of the rack or frame shall be provided for each circuit package. For plug-in devices, two or more contacts in the connector shall be commoned for the earth circuit. Screens on shielded cable shall not be used as a sole earth connection.
- 6.1.23 Removable panels or covers shall, where appropriate, be fitted with captive screws or fasteners.
- 6.1.24 Bolts and screws shall normally engage a threaded length at least equal to the major diameter of the bolt or screw. Screw threads in soft or brittle material shall be adequate for the purpose and metal inserts shall be firmly anchored. Washers shall be used under all nuts.
- 6.1.25 All equipment shall be designated to permit ease of operation and identification for installation and service activities. The designations shall provide contrast with the equipment surface and be legible.
- 6.1.26 Sign writing shall be clean edged, neat and free of brush marks with the characters well formed. Good quality synthetic enamel paints shall be used.
- 6.1.27 Transfers, stickers, charts or any other form of designation may be used subject to acceptance by the APO.
- 6.1.28 Designations shall be provided for:

- Equipment racks.
- Relay sets or circuit packages.
- Relay set or circuit package positions.
- Relays or equivalent components and switch magnets.
- Switch circuit allocations.
- Fuse allocation and ratings.
- Power Supply.
- Jacks, keys, switches and lamps.
- Tool designations.

6.2 CIRCUIT PACKAGES

- 6.2.1 All circuit packages shall be pluggable for replacement, except that if the manufacturer can submit evidence that the product of failure rate and repair time of equipment with direct wired packages is not greater than that with plug connections, direct wiring may be acceptable.
- 6.2.2 The sub-division of a PABX into its circuit packages shall be logical and comply with Clauses 6.2.3 to 6.2.6.

- 6.2.3 Each circuit package should contain only the components required for one feature or function.
- 6.2.4 Where two or more features or functions are included in the one circuit package, they shall be of the same type or related in such a way so as not to critically affect the dimensioning of the PABX.
- 6.2.5 Where a large or complex circuit is divided into more than one package, the removal of one shall have a minimum affect on the performance of the PABX.
- 6.2.6 The maximum size of a circuit package shall be determined by the normal ability of one man to easily replace it in its mounting position (see also Clause 6.1.11).
- 6.2.7 Each circuit package shall be clearly marked with the manufacturer's name or distinguishing symbol, circuit schematic number, issue number, and month and year of manufacture.
- 6.2.8 Different types of circuit package shall be either mechanically different, or the electrical connections shall be so arranged that no damage can occur if a circuit package is inadvertently mounted in the wrong position.
- 6.2.9 All circuit packages shall be rigid and self-protecting from mechanical damage insitu or when unplugged.

6.3 WIRING

- 6.3.1 The wiring of a PABX includes all of the electrical conductors and connections except those which form part of discrete components.
- 6.3.2 Cables shall be used for the electrical connections external to the switching equipment. These cables and their connections shall be in accordance with the requirements of APO Specification 1071 (see also Clause 4.1.4 of this specification).
- 6.3.3 Conductors, conductor grouping and conductor terminations shall be selected so that the whole equipment conforms to the requirements of this specification.

SECTION 7 - RELIABILITY

7.1 RELIABILITY AND LIFE

- 7.1.1 The equipment as a whole shall give a minimum life of 20 years when working in the environment specified in APO Specification 1071. The expiration of life of the equipment will be indicated by the need for maintenance attention greater than that defined by the Mean Time Between Failure (MTBF) and the Mean Time to Repair (MTTR).
- 7.1.2 For design purposes the relativity between traffic and life shall be assumed to be 1500 busy hours per year.
- 7.1.3 The MTBF of the equipment shall be at least:-
- 5000 hours (30 weeks) for installations of up to 50 extension lines,
 - 4000 hours (24 weeks) for installations of 51 to 200 extension lines,
 - 3000 hours (18 weeks) for installations of 201 to 500 extension lines,
 - 2000 hours (12 weeks) for installations of 501 to 1000 extension lines,
 - 1000 hours (6 weeks) for installations of over 1000 extension lines.
- 7.1.4 The MTTR of the equipment shall not exceed one hour for a repairman of average experience and training.
- 7.1.5 Mean Time Between Catastrophic Failures (see definition). The mean time between catastrophic failures shall not be less than the time stated in Table 11.

TABLE 11

MEAN TIME BETWEEN CATASTROPHIC FAILURES

PABX Size	Mean Time Between Catastrophic Failures
Up to 26 extension lines	5 years
Up to 100 extension lines	10 years
Over 100 extension lines	20 years

To achieve this objective, the more critical circuit functions without which the PABX would be inoperative may need to be provided in duplicate and in separate packages.

When the PABX power is supplied by battery eliminators, the reliability of these units need not be considered in assessing the mean time between catastrophic failures. See Clause 11.1.6.

7.2 ENVIRONMENT

- 7.2.1 The standard PABX accommodation is stated in APO Specification 1071.
- 7.2.2 To cater for emergency conditions, such as the breakdown of air-conditioning, the equipment shall perform its functions for 1000 hours when exposed to an ambient temperature in the range 0°C to 50°C with maximum relative humidity of 80 percent.
- 7.2.3 To cater for storage the equipment shall function without permanent damage or loss of performance after having been exposed indefinitely whilst unenergised to any naturally occurring steady or slowly variable combination of ambient temperature in the range -20° to +55°C, and relative humidity up to a maximum of 95 percent.
- 7.2.4 The equipment or any part of the equipment shall meet the requirements of this specification after being subjected to accelerated damp heat test D severity V of Australian Standard C 333.

7.3 COMPONENTS, MATERIALS AND FINISHES

- 7.3.1 Generally the selection of components, materials and finishes to satisfy the requirements of a particular application, and to meet the overall system reliability stated in Clause 7.1 under the environment conditions of Clause 7.2 is the prerogative of the equipment designer. The APO has certain requirements for components also and these are given in Clauses 7.3.2 to 7.3.14.
- 7.3.2 Components, materials and finishes shall comply with a standard of International or National standing (e.g. I.E.C., Australian Standard or British Standard based on I.E.C. recommendations, or Australian, British or U.S.A. Defence Standard) or an APO Specification.
- 7.3.3 The equipment shall be so constructed and its component parts so selected, as to prevent self ignition. Exposure of any part of the equipment to a flame shall not result in an explosive type fire and the part shall not support violent burning. The spread of surface burning on larger parts shall be inhibited.
- 7.3.4 Insulating materials shall be of quality suitable for Australian climatic conditions. They shall be flame retardent preferably in accordance with ASTM Specification D635 for rigid insulation and ASTM Specification D626 for woven textile insulation.
- 7.3.5 The prime characteristic of each passive component shall be a preferred value in accordance with British Standard 2488. Select-on-test components shall be avoided; where used, a typical range of values shall be stated on the schematic circuit diagram. Components with values which require selection within the tolerance marked on them must not be used.
- 7.3.6 Metal surfaces subject to abrasion shall be lubricated with a wax or dry lubricant approved for the purpose by the A.P.O.. Silicone greases and liquids shall not be used in, or in the manufacture of, any part of PABX equipment.
- 7.3.7 Construction methods and materials conducive to the production of metal whisker growth shall be avoided.
- 7.3.8 The direct association of dissimilar metals that may result in mutual electrochemical potentials in excess of 0.5 V shall be avoided by interposition of surface coatings such as plating, metal spraying or painting.
- 7.3.9 Alloys and other materials which may be subjected to environmental conditions that may stimulate intergranular or stress corrosion effects shall be avoided.
- 7.3.10 Iron and steel components and structures, with the exception of those made from stainless steel, shall be finished with a protective coating, which incorporates a rust inhibitor.
- 7.3.11 Copper and brass surfaces exposed to atmospheric contamination shall be protected by plating.
- 7.3.12 The exposed edges of all laminated materials that are subject to fraying or splitting shall be covered or sealed.
- 7.3.13 Generally the following mean operations between failure shall be required for mechanical components:
- 10⁹ for continuously operating devices in common services,
 - 5 × 10⁷ for decadic pulsing relays in common control circuits,
 - 10⁷ for other relays in common control circuits,
 - 5 × 10⁶ for relays in registers and for pulse repetition relays,
 - 10⁶ for relays in feature circuits,
 - 5 × 10⁵ for relays in extension line circuits,
 - 2 × 10⁶ for connecting switches,
 - 10⁶ for cross points,
 - 10⁶ for operators control keys,
 - 10⁵ for maintenance aid controls.

7.3.14 APO standard dials, handsets and their components shall be provided for the operators position. At July 1971 these were the 801 telephone handset and dial DMS-1.

7.4 SWITCHING DEVICES

- 7.4.1 Switching devices that employ ratchets, pawls, shafts or other wearing surfaces that require periodic lubrication of bearings, are not acceptable.
- 7.4.2 A PABX switching device shall be in continuous quality controlled production, and proven in the environment of the PABX.
- 7.4.3 Contacts that may require re-adjustment shall be readily accessible for adjustment. Replaceable contact assemblies shall be readily accessible.
- 7.4.4 The maintenance of switching devices shall be simple and require a minimum of especially acquired manual dexterity. Adjustments shall preferably be screwdriver or spanner operations. Adjustment tolerances should eliminate critical gauging. Bending or stroking adjustments should not be required. Adjustment operations shall be independent.

7.5 CIRCUITRY

- 7.5.1 The circuit design shall be logical and take into account equipment operating limit conditions with allowance for designed manufacturing factors of safety in the selection of each element.
- 7.5.2 The design shall have simple circuitry employing a minimum number of components.
- 7.5.3 Operate values shall be considered on minimum voltage and maximum circuit limit conditions. Non-operate values and power ratings shall be considered on maximum voltage and minimum circuit limit conditions.
- 7.5.4 The failure of one component should not result in the catastrophic failure of, or place undue stress on other components. In particular the voltage regulation and power dissipation of series/parallel circuit arrangements should conform to this requirement.
- 7.5.5 All contacts, that may open or close reactive circuits shall be provided with an arc suppression device.
- 7.5.6 All contacts, that are part of a circuit where the voltage may be less than that required to breakdown any film or deposit which may form on them (e.g. transmission and tone feed circuits), shall be provided with a contact "wetting" circuit.

7.6 MAINTENANCE EQUIPMENT

- 7.6.1 The reliability of maintenance features included in the design of the PABX equipment shall be at least as high as for the remainder of the PABX equipment.
- 7.6.2 The reliability of portable and auxiliary test equipment shall be at least as high as for the PABX equipment, due regard being paid to portability.

SECTION 8. TRANSMISSION PERFORMANCE

8.1 INTRODUCTION

- 8.1.1 Reference Equivalents Although not required for design of a PABX the APO objectives for reference equivalents between the PABX and public exchange are given to facilitate understanding of the overall design requirements. The figures given are effective reference equivalents (see definition). The effects of line plant external to the PABX are included and the use of 800 series telephone transducers of minimum acceptable efficiency when new is assumed. In computing the effects of PABX equipment losses on reference equivalents, it may be assumed that the 800 Hz insertion loss of a test connection in decibels is equal to the reference equivalent of the test connection in decibels.
- 8.1.2 Sending The sending effective reference equivalent from extension telephone or PABX operator to public exchange shall not exceed 16 dB.
- 8.1.3 Receiving The receiving effective reference equivalent from public exchange to extension telephone or PABX operator shall not exceed 5 dB.
- 8.1.4 Send - Receive Difference The sending effective reference equivalent shall exceed the receiving reference equivalent by 7 dB to 11 dB in an extension-to-public-exchange connection.

8.2 GENERAL

- 8.2.1 Nominal Impedance The nominal impedance of all transmission paths and test points shall be 600 ohms resistive over a frequency range of at least 300 to 3400 Hz.
- 8.2.2 Transmission Test Points The following Transmission Test Points (TTP) are to be used at the PABX:

TABLE 12

TRANSMISSION TEST POINTS

Outlet or Inlet	Location of TTP
Exchange and tie lines	Line side of MDF
Extension lines	Line side of MDF
Operator	Two-wire point of operators telephone circuit.

- 8.2.3 PABX Test Connections A test connection is that portion of a nominated connection path located within the PABX: its transmission characteristics shall be measured from the transmission test point. There are eleven principal test connections. These are:

Exchange line to operator
Exchange line to extension line
Exchange line to tie line
Operator to exchange line
Operator to extension line
Operator to tie line
Extension to exchange line
Extension to extension line
Extension to tie line
Tie line to operator
Tie line to extension line

8.3 TRANSMISSION REQUIREMENTS

8.3.1 Extension to Extension and Extension to Operator Between two extension telephones connected to the PABX by indoor cabling (i.e. no external extension), or from such an extension to the PABX operator, the effective overall reference equivalent shall be in the range 9 to 14 dB. Telephone instrument reference equivalents vary with line current. For 800 series telephones on zero line the variations are given in Table 13.

TABLE 13

REFERENCE EQUIVALENTS OF 800 SERIES TELEPHONES
ON ZERO LINE WITH VARIOUS FEED CURRENTS.

Current (mA)	20	25	30	40	50	80	90	95
Receiving r.e. (in dB)	-3.6	-3.4	-3.3	-2.9	-2.3	-0.8	0.1	0.9
Effective Sending r.e. (in dB)	11.8	11.2	10.1	8.7	8.0	7.2	7.1	7.0
Effective Overall r.e. (in dB)	8.2	7.8	6.8	5.8	5.7	6.4	7.2	7.9

The above overall effective reference equivalents are for two zero-line telephones connected directly to each other, each having the same line current. For longer extensions with differing line currents, the overall effective reference equivalents (there are two, one for each direction of transmission) may be calculated from the current columns for sending reference equivalent and receiving reference equivalent. In-service overall effective reference equivalents from extension to extension or extension to operator would be greater by the reference equivalents introduced by transmission loss through the PABX and by the extension lines.

8.3.2 Tie Lines with Access to Public Exchange The objectives in 8.1.2 and 8.1.3 shall be met by all extensions of the second PBX when public exchange access is given via the first PBX, in accordance with Clause 9.6.1.

8.3.3 Operators Telephone Circuit The operators telephone circuit with an 800 series handset shall have reference equivalents as follows at the transmission test point:

Sending : 7 ± 2 dB
 Receiving : -4 ± 2 dB
 Sidetone : not less than 12 dB

The sidetone reference equivalent requirement shall be met when speaking on any connection. Comparable results will be required from headsets; measurement techniques are not specified.

8.3.4 Battery Feed to Extension Telephones To minimise the transmission penalties encountered on a connection between a regulated extension telephone with a low-resistance line and a high-loss exchange line, the battery feed current to an extension telephone, when connected to a line to the public exchange, shall be regulated to be in the range 35 to 55 mA. On extension-to-extension connections a minimum telephone current of 20 mA is permissible, provided the requirements of Clause 8.3.1 are met. These values of current shall be achieved with extension line resistance values up to 1000 ohms (see Clause 9.7.3 for extension signalling limits).

8.3.5 The requirements of Clauses 8.3.6 to 8.3.15 apply to all test connections in the PABX when carrying direct current ranging from 10 mA to 60 mA.

8.3.6 Insertion Loss The 800 Hz insertion loss of a test connection involving an exchange line or a tie-line circuit shall not exceed 0.5 dB, except when the operator enters the connection. Under the latter conditions the additional insertion loss due to the operators circuit shall not exceed:

0.3 dB when the operator listens only
 3.5 dB when the operator speaks.

Entry or withdrawal of the operator for listening or speaking shall not cause clicks on the established connection. All other test connections shall comply with Clause 8.3.1.

8.3.7 Frequency Response The insertion loss of any test connection, relative to that at 800 Hz, may vary with frequency as follows:

In the range 300 Hz to 400 Hz : +0.5 dB to -0.2dB
In the range 400 Hz to 3400 Hz : +0.3 dB to -0.2dB

8.3.8 Group Delay The group delay relative to the minimum group delay in the frequency range 600 Hz to 3000 Hz, shall not exceed 100 microseconds.

8.3.9 Crosstalk Between Test Connections Using a speech-weighted noise source and measuring with a psophometric noise measuring set, the crosstalk attenuation, with the gain of any amplifier set to zero, shall not be less than 75 dB, with 90 per cent of combinations being better than 85 dB, between any two test connections with disturbing and disturbed circuits terminated in the appropriate nominal impedance.

8.3.10 Crosstalk between Test connections via a Common Tone Supply Between two test connections connected to a common tone supply output, with the tone generator switched off, the minimum crosstalk attenuation measured in accordance with Clause 8.3.5 shall be for:

Trunk offering tone	65 dB
Call waiting tone	65 dB
Dial tone	40 dB
Line lockout tone	40 dB
Other tones	55 dB

8.3.11 Noise The objectives for noise performance in a working PABX are as follows:

Psophometrically Weighted Noise

The psophometric noise power on any test connection in any busy hour shall not exceed -72 dBmp.

Unweighted Noise

The mean unweighted noise power in any test connection during any busy hour, measured over the frequency band 30 Hz to 20 kHz shall not exceed -45 dBm.

Impulsive Noise

The impulsive noise count on any test connection during any busy hour shall not exceed 50 counts for an impulsive noise threshold of -49 dBm. The characteristics of the impulsive noise counters are described in the annex to CCITT Recommendation V55 (White Book, Volume VIII).

8.3.12 Impedance Regularity The return loss of any input (or output) of a test connection measured against its nominal impedance shall be not less than 15 dB between 300 Hz and 600 Hz and not less than 20 dB between 600 Hz and 3,400 Hz.

8.3.13 Balance to Earth The impedance balance ratio at the input (or output) of a test connection shall be not less than 40 dB over the range 30 Hz to 600 Hz, 46 dB over the frequency range 600 to 3,400 Hz inclusive and 15 dB over the range from 3,400 Hz to 50 kHz. This clause shall also apply when signalling tones and recorded announcements are applied to the circuit.

8.3.14 Harmonic Distortion The test connection shall be capable of passing +5 dBm at 400 Hz with the total harmonic distortion at least 26 dB below the fundamental.

8.3.15 Intermodulation When a test connection is loaded with any two frequencies f_1 and f_2 which lie in the range 540 Hz to 1,980 Hz, each of the 3rd order intermodulation products (i.e. $2f_1 \pm f_2$ or $2f_2 \pm f_1$) which lie in the frequency range 540 Hz to 1,980 Hz shall be at least 40 dB below each of the fundamentals in level when these fundamentals are of equal level in the range -3 dBm to -36 dBm.

Correspondingly, each of the second-order intermodulation products ($f_1 \pm f_2$) measured under the same conditions shall be not less than 30 dB below the level of each of the fundamentals.

9.1 GENERAL

- 9.1.1 Line and information signals between the PABX and the public exchange shall be in accordance with APO Specification 1105.
- 9.1.2 Line and information signal between extensions and the PABX equipment shall be in accordance with APO Specification 1105 considering the PABX as the public exchange and the extensions as the subscribers equipment.
- 9.1.3 Where the requirements of APO Specification 1105 differ from those of APO Specification 1080, the requirements of APO Specification 1080 shall apply.
- 9.1.4 Signalling within the PABX may be of any reliable type which does not interfere with the public network.
- 9.1.5 Types of signals that may be associated with a PABX are shown in Table 14.

TABLE 14

PABX LINE SIGNALS

PABX line signalling direction	DC decadic loop disconnect interruptions	DC to earth	Low frequency AC ring	Voice frequency tone signals
To PABX	(a) extension lines. (b) indialling exchange lines.	(a) enquiry signals from extension lines. (b) some types of push-button extension lines.	(a) ring-in exchange lines. (b) tie-lines to the PABX operator.	(a) some types of indialling exchange lines. (b) full feature active working tie-lines. (c) some types of push-button extension lines.
From PABX	(a) dialling outgoing exchange. (b) dialling tie lines.		(a) extension lines. (b) outgoing tie-lines to a distant PBX operator.	(a) exchange lines from very large PABX. (b) full feature active working tie-lines. (c) exchange lines with VF push-button signalling.

- 9.1.6 Bothway lines that terminate on automatic switching equipment at both ends shall include signals (early guard, AC clearing, equipment released, etc.) to reduce the possibility of double seizure and ineffective follow-on calls to not more than one in one thousand calls offered to the line. Information to assist in achieving this objective is contained in Appendix 1 of this specification.

Early guard signal shall be applied from the seized end of the circuit immediately following selection and shall consist of the application of the seizure signal (ring or loop) or special early guard signal such as negative potential applied to the normal positive leg of the circuit. Where the number of lines is six or less and the order of selection is sequential at both ends an early guard signal might not be necessary provided the unguard times are minimised.

AC clearing signal is defined as PABX AC clearing signal in APO Specification 1105 and is applied from the PABX 350 to 450 milliseconds after the detection of the extension clearing signal, or the release of the line at the operators position, until the return of the distant end termination to an unbalanced (free) condition is detected. It is then removed from the line and the circuit is freed for further traffic from either end.

Equipment released signal is defined in APO Specification 1105 and indicates to the PABX that the distant end termination is free.

9.2 DECADIC SIGNALLING

- 9.2.1 Decadic signalling from PABX equipment shall conform to APO Specification 1105 and also the requirements of Clauses 9.2.2 to 9.2.6.
- 9.2.2 For automatic pulse generators the minimum interdigital pause shall be at least 800 milliseconds.
- 9.2.3 The break pulse shall have a source resistance to line of more than 19 megohms with any potential 0 to 250 volts DC applied.
- 9.2.4 The voltages wave shape to the exchange line at the PABX under the worst normal dynamic condition should be rectangular. Any overshoot oscillations shall be contained within the break pulse and shall not overshoot the DC make potential. For at least half of the break pulse time the peak to peak amplitude of any oscillations shall not exceed 25 per cent of the applied DC potential.
- 9.2.5 Momentary breaks in the line termination are not permitted during the drop back from the pulsing condition. If the normal line termination has a time constant exceeding 2 milliseconds, the drop back from the pulsing condition shall be voltage controlled or arranged in a number of time controlled stages, such that, the termination at the end of each train of pulses initially has a time constant of less than 2 milliseconds and the reactive elements are then fluxed before each is connected to the circuit.
- 9.2.6 Where PABX equipment either directly or indirectly passes or repeats decadic loop-disconnect pulses, generated from some other sources, e.g. telephone instruments to the public exchange network, the distortion limits set out in Table 15 shall apply when measured in accordance with a test configuration shown in APO Specification 1081.

TABLE 15

ACCEPTABLE PULSE DISTORTION WITH EACH LINE CONDITION AND SUPPLY VOLTAGE

	Pulse source (speed, ratio, time)					
	Speed pps	8	8	10	12	12
	Ratio (break) (make)	7:3	3:2	2:1	7:3	3:2
	Break Time	87 ms	75 ms	67 ms	58 ms	50 ms
	Make Time	38 ms	50 ms	33 ms	25 ms	33 ms
Permissible lengthening of 1st break pulse	4 ms	4 ms	2 ms	4 ms	12 ms	
Permissible lengthening of any break pulse (other than 1st)	2 ms	2 ms	Nil	2 ms	10 ms	
Permissible shortening of any break pulse	10 ms	6 ms	4 ms	6 ms	6 ms	
Permissible lengthening of any make pulse	6 ms	6 ms	4 ms	10 ms	6 ms	
Permissible shortening of any make pulse	2 ms	10 ms	Nil	2 ms	2 ms	

Note: The distortion is the difference between the length of any break or make pulse in a train of pulses at the input of the line condition circuitry and the output of the intermediate pulse repeater.

9.3 PUSH-BUTTON SIGNALLING

9.3.1 VF push-button signalling in accordance with APO Specification 1105 may be used for transmission of address signals within the PABX, or between the PABX and the public exchange where this is appropriate.

The long term objectives for the development of the public exchange network include the possibility of telephones being equipped with push-buttons for setting up calls and for transmitting casual data. It is therefore desirable that when PABX extensions are equipped with push-button telephones, signalling between the PABX and the public exchange should use the VF push-button signalling mode if the exchange is capable of receiving the address signals in that mode. Other forms of push-button signalling may be acceptable between the extension telephones and the PABX provided that the approved tone type keypad is used.

9.4 MFC SIGNALLING

9.4.1 The standard method of information signalling between public exchanges in the Australian network is the MFC compelled sequence system detailed in APO Specification 1078. It is desirable that this method of information signalling be used between PABXs and the public exchange whenever possible and economical.

9.4.2 MFC signalling from special PABXs to public exchanges (Feature List C) shall be provided in accordance with APO Specification 1078. PABXs with this feature will be arranged in the network to have the status of a terminal exchange for transmission, signalling and network analysis functions.

9.4.3 MFC indialling from the public exchange (Feature List C) This feature may be provided for large PABXs when the public exchange has MFC signalling capability and indialling is required. Such PABXs shall perform in accordance with APO Specification 1078 as if the PABX had terminal exchange status.

9.5 EXCHANGE LINES

9.5.1 PABX exchange line circuits are classified in accordance with Table 16.

9.5.2 Polarity Requirements PABX exchange line circuits should function independent of the line potential normal polarity. However, there may be some functions (e.g. decadic pulsing, trunk barring, metering, preguard for bothway lines) which are polarity dependent. Outgoing exchange line circuits that are dependent upon a particular line polarity shall also provide polarity correcting circuitry or an automatic guard arrangement that prevents the circuit from being seized for outgoing traffic if the line is:

reversed,

open circuit either or both legs,

short circuit, (less than 100 ohms) across the line
or from the normal negative leg to earth.

Such a guard circuit shall initiate supervisory indicators for operators (see Clause 3.3.2), service indicators (see Clause 12.1.3) and operate an alarm (see Clause 12.5.22).

In the idle condition, it shall present a resistance of not less than 500,000 ohms to the line, leg to leg and either leg to earth at 250 volts DC.

9.5.3 Incoming ring circuitry for exchange lines (for I/C-R-0, B/W-RD-0 and B/W-RD-E circuits) at the PABX shall meet the requirements of Clauses 9.5.4 to 9.5.6.

9.5.4 Ring Circuit - Idle In the idle condition the incoming ring circuit shall provide a balanced termination (except for bothway circuits that require an early guard signal from the exchange on one leg of the pair) comprising an effective resistance of not more than 5000 ohms in series with an effective inductance of not more than 30 Henries, in series with an effective capacitance of 1.5 ± 0.5 microfarads for frequencies up to 50 Hz. The leakage resistance of the capacitor forming part of the line termination shall not be less than 300 megohm microfarad at 500 volts DC. The termination shall be capable of withstanding sustained ringing voltages of 100 volts rms at any frequency in the range 15 to 50 Hz.

9.5.5 Ring Signal Detection The ring signal detector shall respond uniformly to ringing signals received over telephone lines when the signal performance and line tolerances conform to the limit requirements of APO Specification 1105 but shall be insensitive to transients of 100 volts.

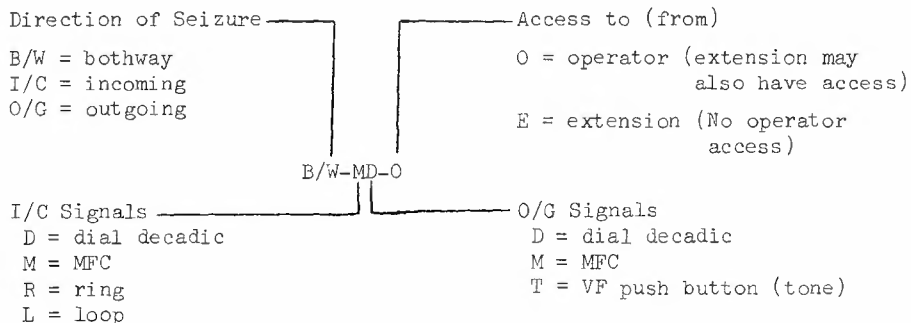
TABLE 16

TYPES OF EXCHANGE LINE CIRCUITS

		Bothway (B/W)						
		Incoming to PABX (I/C)			Outgoing from PABX (O/G)			
	Ring	Dial Decadic	Loop	MFC	Dial Decadic	VF Push-Button Tone Signalling	MFC	
	I/C-R-O	I/C-D-O	I/C-L-O	I/C-M-O	O/G-D-O	O/G-T-O*	O/G-M-O*	Uni-direct-ional
	B/W-RD-O				B/W-RD-O			Normal
Operator Access (extns may also have access)	B/W-DD-O*				B/W-DD-O*			
			B/W-LD-O*		B/W-LD-O*			
			B/W-LM-O*				B/W-LM-O*	
				/W-MD-O*	B/W-MD-O*			
				/W-MM-O*			B/W-MM-O*	
	B/W-RT-O*				B/W-RT-O*			
		B/W-DT-O*			B/W-DT-O*			
			B/W-LT-O*		B/W-LT-O*			
				/W-MT-O*	B/W-MT-O*			
	I/C-R-E*	I/C-D-E		I/C-M-E	O/G-D-E	O/G-T-E*	O/G-M-E*	Uni-direct-ional
Direct Exten Access (no operator access)	B/W-RD-E				B/W-RD-E			Sub-attended
		B/W-DD-E*			B/W-DD-E*			
				/W-MD-E*	B/W-MD-E*			
				/W-MM-E*			B/W-MM-E	
		B/W-RT-E*				B/W-RT-E*		
		/W-DT-E*			B/W-DT-E*			
				B/W-MT-E*	B/W-MT-E*			

* NOTE: No general application as at 1971

Example A bothway circuit to the operator, MFC incoming signals and dial decadic outgoing signals is classified as B/W-MD-O.



9.5.6 Ring Trip Ring trip shall present a low DC resistance balanced termination to the line (preferably 10 ohms or less) for 200 to 300 milliseconds from the operation of the answer key on the operators position before the normal loop (answer) signal is then applied without discontinuity. Arrangements shall also be made to prevent ring or switching noises (see Clause 8.3.11) from passing to any telephone or operators receiver that may be in use.

9.5.7 Indial Circuits (I/C-D-O and I/C-D-E) shall provide the features specified in Clauses 9.5.8 to 9.5.12 for exchange lines at the PABX.

9.5.8 Indial Circuits - Incoming Signals The indial circuit shall receive signals from the public exchange under combinations of limit conditions:

Seizure signal up to 4000 ohms loop (includes 1000 ohms in public exchange equipment).

Address signals in accordance with APO Specification 1105.

Clear forward signal (see APO Specification 1105). The clear forward signal shall initiate the release of the switching path through the PABX and cause the application of release guard and blocking signal to the exchange.

9.5.9 Indial Circuits - Outgoing Signals Indial circuits shall transmit signals, as required by APO Specification 1105, in accordance with the following:

Answer signal shall be achieved without chatter or oscillation, within 100 milliseconds after ring trip detection at the PABX.

Clear back shall be achieved without chatter or oscillation 400 to 500 milliseconds after the detection of the called extension clearing signal at the PABX or immediately following the operation of a release function by the PABX operator to whom the call had been switched. Release of the switching path through the PABX shall commence coincident with the application of the clear back signal to the exchange line.

Re-answer Following clear back, if a PABX operator re-enters the connection, a signal identical to answer signal, shall be applied to the line. An extension shall not initiate a re-answer signal following a clear back signal on the same call.

Release guard and blocking shall be applied within 50 milliseconds of the clear back signal unless the PABX has released in this time. If the circuit is free, it shall also be applied when the circuit blocking function at the PABX is operated (see Clause 12.2.4). It shall continue until the PABX switching equipment associated with the exchange line is released and the exchange line circuit is available to receive a fresh call from the exchange or until the circuit blocking function at the PABX is released, whichever is the longer time. A supervisory alarm for the exchange line circuit shall be operated at the PABX during the application of the release guard signal (see Clause 12.5.22).

9.5.10 Maximum Pre-dialling Delay Response If, after receiving a seizure signal from the public exchange, the PABX provides a lock out feature of the form that prevents a seized in-dial circuit from responding to loop disconnect signals, the circuit shall return busy tone to the line. The shortest period in which this may occur is the maximum pre-dialling delay for the incoming call and this shall not be less than 10 seconds.

9.5.11 Minimum Inter-digital Pause Response During the reception of loop disconnect address signals from the public exchange, the shortest value of make pulse that results in the break pulses being identified as single digits in successive trains is the minimum inter-digital pause response. The minimum inter-digital pause response shall be within the range 150 to 450 milliseconds.

9.5.12 Reversal Blink The absence of potential applied to the exchange line during the initial application of the answer signal, clear back or re-answer is the reversal blink. Ideally there should be no reversal blink but a blink of no more than 4 milliseconds may be acceptable.

9.5.13 Outgoing Dial Decadic (O/G-D-O, O/G-D-E) exchange line circuits at PABXs shall meet the requirements of Clauses 9.5.14 to 9.5.17.

- 9.5.14 Outgoing Dial - Idle Condition In the idle condition, outgoing dial decadic exchange line circuits shall provide a termination that is effectively an open circuit to DC except if a polarity guard circuit is provided (see Clause 9.5.2) or the circuit is also a bothway circuit (see Clause 9.5.18).
- 9.5.15 Outgoing Dial - Signals Outgoing dial decadic exchange line circuits shall transmit the signals defined by APO Specification 1105 in accordance with the following:
- Seizure - 100 to 300 ohm DC loop immediately following selection of the circuit by the PABX equipment.
- Hold - 100 to 600 ohm DC loop during the progress of the call except during other signals.
- Decadic pulsing - in accordance with Clause 9.2.1.
- Change of category - (see Clause 3.2.6) in accordance with performance standards of APO Specification 1105.
- Clearing - a signal in accordance with 9.5.14 above shall be applied to the line immediately following the detection of the extension clearing signal, or the operation of the exchange line clear function at the operators position, whichever is last when the operator is involved with the call (see Clauses 3.3.2 and 3.3.8). However, this is not to be confused with release of the PABX switching equipment (see Clause 9.5.16) or PABX AC clearing (see Clause 9.1.6).
- 9.5.16 Outgoing Dial - Release On outgoing dial decadic exchange lines, release of the PABX switching path shall commence 350 to 450 milliseconds after the detection of the extension clearing signal or immediately following the operation of the exchange line release function at the operators position.
- 9.5.17 Outgoing Dial - Guard On outgoing dial decadic exchange lines, the circuit shall be guarded from subsequent fresh call seizure for not less than 800 and not more than 2,000 milliseconds after the application of the clearing signal to the exchange (see Clause 9.5.15), unless the circuit is adequately guarded by the detection at the PABX of an equipment - released signal from the exchange or the satisfactory operation of the PABX AC clearing function (see Clause 9.5.18). A supervisory alarm for the exchange line circuit shall be operated at the PABX if the circuit is not free and available for subsequent traffic after this guard period (see Clause 12.5.22).
- 9.5.18 Bothway Exchange Line Bothway exchange line circuits (B/W-RD-O, B/W-RD-E) shall conform to the requirements for incoming and outgoing exchange line circuits with the appropriate form of signalling in each direction, and shall additionally provide circuitry to satisfy the signal and performance requirement of Clause 9.1.6 by minimising the double seizure risk time by the application at the PABX of the guard features specified in Clauses 9.5.19 to 9.5.24.
- 9.5.19 Bothway Lines - Preguard Preguard shall be applied at the PABX to prevent seizure for an outgoing call immediately following the detection of early guard signal from the exchange. The incoming seizure risk time is the total time taken for the application of early guard signal at the public exchange and its detection and the application of preguard at the PABX. For design purposes the application of early guard signal at the public exchange may be assumed to be 50 milliseconds. The early guard signals from current type APO exchanges are:
- Ring Ringing signal of 360 to 440 milliseconds duration from crossbar exchanges on B/W-RD-E and B/W-RD-O circuits (see Table 16).
- Negative Potential The application of 46-54 volts negative potential with respect to earth applied to the normally positive leg of the line through a resistance of 1,000 ohms maximum from most step exchanges on B/W-RD-E and B/W-RD-O circuits.
- When B/W-DD and DM-E and O circuits are introduced for crossbar exchanges the early guard signal will be a loop of 600 ohms maximum applied at the exchange. These circuits are not expected to have an application for step exchanges.
- 9.5.20 Bothway Lines - Seizure On bothway exchange lines, the seizure signal shall be applied at the PABX immediately following selection of the circuit for an outgoing call. The outgoing seizure risk time is the total time taken for the application of the seizure signal at the PABX and its detection and guard at the public exchange. The detection and guard time for the exchange equipment may be assumed to be 50 milliseconds.

9.5.21 AC Clearing Signal The exchange line circuitry, in accordance with Clause 9.1.6 shall apply the AC clearing signal to the exchange line from a supply in accordance with Clause 10.4.1. For the time that the AC clearing signal is applied to the line, the circuit at the PABX shall be guarded to prevent its seizure for an outgoing call. The circuitry shall consist of a bridge circuit so arranged that there is no DC loop applied to the line or from either leg to earth. The signal is sent longitudinally with respect to earth, to both legs of the line. It shall detect an unbalance of resistance (or inductance) at the public exchange end of the line without detrimental effect to the normal operation of the exchange end. The sensitivity of the PABX AC clearing circuitry shall be in accordance with the test requirements of APO Specification 1081. The AC clearing signal shall be removed from the line immediately the public exchange end unbalance is detected. The PABX calling signal detector shall be restored to the line prior to removing the outgoing seizure guard.

9.5.22 Equipment-Release Signal Equipment - released signal (a reversal of the potential applied to the line) may be available for some B/W-RD-E and O circuits from crossbar exchanges but it shall not be used for B/W-DD or DM circuits which feed potential from both ends, because critical timings would be necessary to ensure that circuit lock-up via the line did not occur.

The circuitry of B/W-RD-E and O circuits using this form of equipment-released signal shall include functions identical with the automatic guard arrangement outlined in Clause 9.5.2. Thus the circuit shall not be available for outgoing traffic to the public exchange unless the polarity of the feed from the exchange is normal, indicating an exchange free condition.

9.5.23 Release Guard and Blocking When B/W-DD, LD, LM, etc. circuits are introduced, double seizure will be prevented by release guard and blocking signal in accordance with Clause 9.5.9 in association with a function similar to the automatic guard outlined in Clause 9.5.2.

9.5.24 Simultaneous Seizure The circuit arrangement at the PABX shall be so such that in the event of the detection of an early guard signal from the public exchange simultaneous with the seizure of the circuit by an outgoing exchange call, the incoming call shall take precedence and be processed in the normal manner and the outgoing call shall be offered to another free exchange line in the normal manner.

9.6 TIE-LINES

9.6.1 Tie-line circuits are categorised by their exchange access at the relevant PBX and their signalling conditions, for which compatible circuitry shall be provided at each PBX.

Tie-line exchange access conditions are specified in Clauses 9.6.2 to 9.6.6.

9.6.2 No Exchange Access No exchange access is the normal condition, with public exchange access in either direction prevented.

9.6.3 Exchange Access - Incoming Incoming exchange call access to the tie-line is available and outgoing access from the tie line to the public exchange is barred. The APO permits this under certain circumstances and when the overall transmission requirements of Clause 8 can be satisfied. Circuits are subject to APO approval.

9.6.4 Exchange Access - Outgoing Incoming exchange calls are barred from the tie-line and outgoing access is available from the tie-line through the PABX to the public exchange. This is not normally permitted.

9.6.5 Exchange Access - Bothway Total access for public exchange connections to and from the tie-line. This is permitted only for very special circumstances.

9.6.6 Exchange Access - Distant End Public exchange access at the distant PBX. The distant PBX exchange access will be as for Clauses 9.6.3 to 9.6.5. The overall transmission requirements of section 8 shall be satisfied. Exchange access at both ends of the same tie-line shall be prevented.

9.6.7 Signalling The signalling system for a tie-line shall be compatible with the distant PBX (as outlined in Clause 9.6.9) and the characteristics of the transmission path. For dialling tie-lines on DC circuits, decadic loop-disconnect signalling shall be employed. On derived circuits, signalling appropriate to the type of circuit shall be used. The signals shall generally be in accordance with Specification 1078.

9.6.8 Pulse Performance Tie-lines with dialled exchange access shall conform overall to Clause 9.2. Thus the permissible pulse distortion shall be apportioned between the originating PBX, including its outgoing tie-line circuit, the tie-line transmission path, including intermediate repeaters, and the exchange access PBX including its incoming tie-line circuit and outgoing exchange line circuit.

9.6.9 Terminations At Distant PABXs The type of tie-line termination at the distant PBX would usually be one of the following:

Cord Type PMBXs to APO drawing CE-250 - An exchange line circuit in accordance with Fig. 1 of that drawing.

Cordless type PMBXs to APO drawings CE-11029, CE-11239 or CE-11240 - An exchange line circuit to the appropriate drawing.

PABXs, Direct to the Operator - An exchange line appearance generally in accordance with Clause 9.5.3.

PABXs, Direct to automatic switching equipment - An extension line appearance generally in accordance with Clause 9.7.

PABXs bothway dialling - A special bothway dialling tie-line circuit which satisfies the requirements of Clause 9.6.10.

9.6.10 Bothway Dialling Bothway dialling tie-line circuits shall conform to the requirements of Clause 9.1.6. Special care shall be taken to prevent circuit lock-up occurring under any condition due to a difference of up to 10 volts in the DC potentials applied to line by the two PABX tie-line circuits. Reversals shall not be used for bothway tie-line signalling. Any abnormal line or distant termination condition that prevents selection of a tie-line that is not carrying traffic shall result in an alarm in accordance with Clause 12.5.22.

9.7 EXTENSION LINES

9.7.1 The PABX equipment shall be compatible with all standard APO simple service facilities that may be connected to its extension lines. These facilities are described as Standard Telephone Facility Plan Nos. 14, 15, 16, 17, 18, 19, 20, 21 and 22 in APO E.I. TELEPHONE Substation A 0010 and also in the APO Technicians Handbook "Subscribers Equipment Installation Diagrams".

9.7.2 Signalling Unless otherwise specified herein, the extension line characteristic tolerance and signalling performance of the PABX equipment shall be in accordance with APO Specification 1105 when inter-working with extension telephone apparatus having a signalling performance meeting the requirements of that specification. Also see Clause 9.1.2 of this specification.

9.7.3 The normal extension line resistance signalling limit for PABXs to Feature Lists AU, BU and C may be less than 3000 ohms (plus instrument resistance for loop resistance) but shall be not less than 1000 ohms at the minimum specified supply voltage at the PABX provided that equipment is also available with the PABX to achieve the 3000 ohm requirement of Specification 1105 on stipulated extension lines when required for particular installations.

For PABXs to Feature Lists AL and BL, a lower extension line resistance signalling limit, (e.g. 100 ohms) is acceptable.

9.7.4 Extension Battery Feed The continuous power rating of the battery feed at the PABX shall allow for any short circuit or earth fault condition on the line with the normal working voltage at the PABX.

9.7.5 Contact Bounce Sensitivity The PABX equipment shall be insensitive to pick up and release contact bounce, of up to 100 milliseconds duration, from extension facilities.

9.7.6 Transients On established calls the PABX equipment shall be insensitive to interconnection with another extension line or a public exchange line for periods not exceeding 10 milliseconds during switching on extension facilities.

9.7.7 Initiation of Enquiry The enquiry call and call transfer features shall be initiated by the operation of a push-button at the extension instrument to transmit a distinctive signal. The only currently approved signal for this purpose is the application of a differential earth connection signal of not less than 50 milliseconds duration at the extension instrument. The resistance of the earth connection will be 250 ohms or less at the extension instrument.

9.7.8 Release Release of an established call shall not occur until at least 250 milliseconds after loop disconnection from one of the extensions engaged on the call (for release conditions on exchange and internal calls see Clauses 9.5 and 3.1 respectively).

9.7.9 Signalling Potentials The nominal DC line potentials applied from the PABX to the extension lines by transmission battery feed circuits and line circuits shall at all times be:

Leg "a" negative 50 volts DC

Leg "b" earth potential

Ringling current shall be applied on the "a" leg of the extension circuit.

SECTION 10. COMMON SERVICES

10.1 GENERAL

10.1.1 PABX common services include:

- Ring supplies,
- Ring feeds and supply switching arrangements,
- Tone supplies,
- Tone feeds and supply switching arrangements,
- Other signal supplies, feeds and switching, e.g., earth pulses.

10.1.2 Feeds The feeds for each common service shall be mutually independent so that a normal or abnormal condition in any supplied circuit, or the wiring thereto, will not impose a high risk of interference with the supply of the common service to any other circuits. Maintenance facilities shall be provided to isolate or bypass any common feeds.

10.1.3 Output Monitoring The ring supply voltage, each tone, AC Clearing and pulse source shall be continuously monitored so that if any source fails, the appropriate switching and alarm functions will operate.

10.1.4 Duplicate Sources PABXs with more than approximately 26 extensions shall be capable of being provided with duplicate sources for each common service, with change-over arrangements that are initiated by a source failure as specified by Clause 10.1.3. The change-over arrangement may be individual to each type of source or grouped so that all loads change to duplicate sources if any one fails. The change-over arrangements may be self restoring but the circuitry shall prevent hunting between alternate sources. Manual switching and locking on facilities shall be provided. Visual indicators shall show which source is connected to the equipment at any time.

10.2 RING

10.2.1 Ringling Current Ringling current shall meet the requirements of APO Specification 1104, except that for small fixed dimension type PABXs of up to approximately 100 extension lines capacity, a psophometric voltage not greater than 775 millivolts may be acceptable.

10.2.2 Rating The VA rating for each ring supply shall be calculated from the following expressions:

$$VA = 1.255N \text{ ----- } 1$$
$$Ar = \frac{\alpha E}{2P} (0.133 (1-\eta) + 0.0175\eta) \text{ ----- } 2$$

where N in expression 1 is the number of ringing circuits simultaneously in use during the busy hour and is taken from Erlang Table A (See Engineering Instruction PLANNING Traffic K 0100) at 0.001 grade of service and using Ar calculated from expression 2 where:

Ar is the total traffic offered to the ringer during the busy hour in Erlangs.

α is the maximum traffic carrying capacity per extension of the PABX in Erlangs.

E is the maximum number of extension lines that may be connected to the PABX.

P is the number of ring phases.

η is the ratio $\frac{\text{External Traffic}}{\text{Total Traffic}}$

The value of α should be taken to the next highest tenth of an erlang from the maximum calculated and in no case shall be less than 0.2. The value of η should be chosen where α is a maximum.

10.2.3 If the AC Clearing supply is taken from the ringer an allowance for this should be made in the calculation of VA rating.

10.2.4 Figure 1 shows a graph of VA rating versus extension capacity using sample values of α and η .

Ring supplies rated at less than 5 VA are not acceptable.

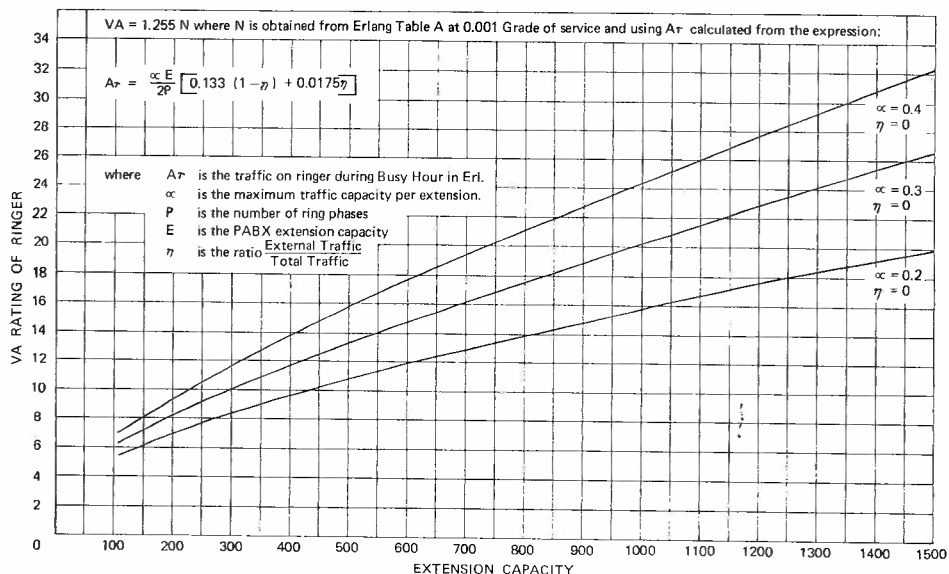


FIG. 1. RATING OF RINGERS.

10.3 TONES

10.3.1 APO Specification No. 1104 "Audible Signals for the Australian Telephone Network" describes the waveform, interruption cycles and level of audible tones required in PABXs. When the features of the PABX require the following tones, they shall be generated in accordance with that specification:

- Dial Tone
- Ringing Tone
- Busy Tone
- Number Unobtainable (NU) Tone
- Call Waiting Tone
- PABX Trunk Offering Tone
- Congestion Tone

10.3.2 The waveform and interruption cycle of tones which are not transmitted to the public exchange network need not meet this requirement if they are aurally recognisable as standard tones. Compliance will be determined by subjective tests.

10.4 OTHER SIGNALS

10.4.1 AC Clearing An AC Clearing supply shall be provided for PABX equipment with bothway exchange line circuits in accordance with Clause 9.5.18. The frequency shall not be less than 16 Hz or more than 35 Hz. The supply shall have an output capacity adequate to allow clearing of the maximum number of the bothway exchange lines that may simultaneously be connected to it. Minimum full load output voltage, measured at its connection point to the exchange line circuits, shall be stipulated for the PABX type and the no-load voltage shall be regulated to be less than 100 volts rms. The AC Clearing supply shall not be interrupted. The ring supply may be used as an AC Clearing supply provided the requirements of Clauses 10.2.2 and 10.2.3 are simultaneously satisfied.

10.4.2 Common potential pulses (e.g. earth pulses of various duration and periodicity) are required to control switching, signalling, indicating, alarm and other maintenance circuits. The source impedance shall be such that none of the individual load circuits fail to operate due to the total normal circuit loads. The source impedances of common pulses shall be capable of absorbing the power overload from a short circuit in any part of the supply wiring.

SECTION 11. POWER

11.1 POWER SUPPLIES

11.1.1 APO standard power equipment for PABXs comprises a 50 volt DC supply regulated between 48 and 52 volts, with its positive terminal connected to earth, to suit equipment designed to operate in the range of 46 to 54 volts. Twenty four lead acid secondary cells are provided as a constant voltage float battery. The regulated source is powered from either 400-450 volts or 200-250 volts, 50 Hz commercial mains with normal voltage variations of +10 to -10 per cent from nominal.

The items of power equipment are specified in APO Specification 1071.

11.1.2 The output voltage regulation and power ratings of all power supplies shall permit the PABX to meet its specified performance (generally stipulated by minimum working voltage) whilst catering for its peak load.

11.1.3 Auxiliary voltages that do not exceed 120 volts DC or 30 volts (peak) AC may be used for switching and control functions (relays, lamps, etc.), but one side of each supply shall be connected to earth at its source.

11.1.4 Batteries may be eliminated from the power supply of PABX types that conform with Clause 3.4.15 and for which a battery eliminator power supply unit is provided (see Clause 11.1.7).

11.1.5 Battery eliminators and auxiliary voltage supplies shall be considered to be part of the PABX, even if they are located separately from the switching equipment, and shall conform to the other requirements of this specification except as indicated in Clause 11.1.6.

11.1.6 The mean time between failures of battery eliminators shall not be less than 10 years.

11.1.7 PABX battery eliminators and auxiliary voltage supplies powered from commercial mains shall conform to the relevant clauses of APO Specification 876.

11.1.8 In addition to the performance tests described in APO Specification 876, a short circuit test shall be applied to battery eliminators and auxiliary voltage supplies. In the test, when a short circuit is applied to the output terminals, no damage shall occur to any component except the fuse.

11.2 PROTECTION

11.2.1 PABX equipment shall be protected from internal and external power source hazards and shall prevent injury to users, operators and service staff, and serious damage to the equipment and accommodation.

11.2.2 Isolating devices (such as fuses and circuit breakers) shall be provided for most applications, although self restoring devices that place into the circuit path a high series impedance (such as barretters and overload relays) may be acceptable when frequent transient overloads cannot reasonably be avoided and the protection they provide is adequate.

11.2.3 Each isolating device shall give a visual indication when it is operated and also provide an alarm in accordance with Clause 12.5.11. Isolating devices shall be capable of simple and speedy restoration after operation.

11.2.4 As the power mains distribution overload isolator is remote from the PABX power rectifier equipment, a further isolator, rated at an operating value less than the distribution isolator, shall be provided on the power supply unit. Unless the connection from the commercial power mains is to be completed with permanent wiring and the active leg is identifiable, an identically rated overload isolator shall be provided in each wire of the mains connection (except the earth) on the power supply unit.

11.2.5 The output and each shunting element, such as electrolytic capacitor or battery of the power rectifier equipment shall be provided with an overload isolator. Generally the principal power distribution isolation elements shall be the power rectifier output fuse, the battery fuse, and a main fuse, a separate fuse or its equivalent will be required in the feed to each suite of not more than five frames or cabinets. The isolators shall be dimensioned so that the operating current, due to a fault, on one feed, plus normal current on all other feeds does not operate the higher rated isolator before the faulty feed is independently isolated.

11.2.6 Final distribution overload isolators for circuits shall be provided in the same frame or cabinet as the circuits they are protecting; they should be on or near to the particular circuit mounting and be designated. The designation shall include the isolator rating if the equipment uses physically similar isolators with different ratings.

Generally each circuit function of the PABX should be separately protected and the operation of an isolator should prevent the circuit from being seized for traffic. The designer shall give due attention to the possibility of, feedback paths and incorrect circuit interaction whilst any circuit is isolated at an overload protection device.

11.2.7 Designs which use miniature cartridge type fuses with a rating of 100mA or less will only be accepted in special circumstances.

11.2.8 Abnormal foreign potentials may appear in external circuits connecting to the PABX (extension, exchange or tie lines) due to:

Induced lightning surges,

Power line induction and contact,

Power system earth faults.

Under no circumstances shall the presence of such potentials cause damage to any common control equipment. Any damage shall be confined to individual line circuits.

PABX installations in areas where the lightning level is high, should have lightning arresters type C, in accordance with APO Specification 975, fitted to each line with significant aerial construction. Consequently it is undesirable to provide arresters in the equipment.

11.2.9 The design shall use techniques that give adequate protection from damage by normally encountered line surges, and from fire or other major damage by abnormal surges and contacts which may cause component failure.

SECTION 12. MAINTENANCE

12.1 GENERAL

12.1.1 The APO approach to PABX service is to restore faulty items of equipment to correct operation with minimum delay and inconvenience to the customer. Reliance is placed not only on the personal report of the customer but also on the automatic display and extension of important interruption conditions to the APO service centre.

12.1.2 The PABX shall be suitable for operation without the attendance of technical staff except for occasional visits following fault reports. The bulk of the work in diagnosing and correcting faults shall be possible using trained, but non-specialist, technical staff.

12.1.3 Maintenance aids shall be an integral part of the PABX design, except that, in cases of modification of PABX types previously approved by the APO, or for systems that were developed for other telephone administrations and are imported, the provision of auxiliary equipment may be acceptable. The required maintenance aids are listed in Table 17.

TABLE 17

MAINTENANCE AIDS

Aid	Reference	Requirement
Access and Connection for Testing	12.2	All PABXs
Functional Test Set	12.3.2 12.3.7	(i) Feature List C - All PABXs (ii) Feature Lists A and B - With first in PABX in the area.
Automatic Circuit Routers	12.3.2	Alternative to functional test set.
Fault Location Aids	12.3.3 12.3.4 12.3.5 12.3.6 12.3.7	(i) Feature List C - All PABXs (ii) Feature Lists A and B - With first in PABX in the area.
Fault Recorders - local printout	12.4.1	(i) Over 1000 extensions - All PABXs (ii) Available for all Feature List C PABXs.
Remote Printout from Fault Recorder	12.6.7	Available for PABXs of over 1000 lines.
Service control Meters (i) Marker operations and failures (ii) Full provision	12.4.3	All PABXs All PABXs to Feature List C
Service Alarm	12.4.4	All PABXs to Feature List B and C
Equipment Alarms	12.5	All PABXs
Extended Alarm	12.5.8	All PABXs to Feature List B and C
Extension Test	12.6.1	All PABXs
Automatic Answering Unit	12.6.6	All PABXs to Feature List C with indialling
Tools	12.1.9	All PABXs
Equipment Extenders	6.1.14	All PABXs where components or circuit packages are inaccessible in the normal working position.

- 12.1.4 Warnings of faults and other unstandard conditions shall be given to the APO service organisation. (See Clause 12.5).
- 12.1.5 The order of automatic selection of shared devices, circuits, etc., shall be so that the effects of any fault are limited.
- 12.1.6 Arrangements shall be made for the diversion of traffic from the affected area, e.g. faulty equipment shall wherever possible be automatically busied so that live traffic is directed to working equipment only.
- 12.1.7 Devices shall be provided for the swift diagnosis of any trouble and for determining the location of the affected part or parts.
- 12.1.8 Access shall be available for in-situ or on-site correction of defects of a minor nature and easy replacement of sub-assemblies and relay sets. (See Clause 6.2.)
- 12.1.9 Properly designed high quality tools shall be provided to perform all of the maintenance activities that may be required to the PABX equipment at the PABX location.
- 12.1.10 Packaging shall be provided for the safe transport and storage of all replaceable sub-assemblies and relay sets.
- 12.1.11 There shall be facilities for the complete functional performance testing at the PABX location of all repaired or changed devices prior to re-connecting them to traffic.

12.2 ACCESS TO PABX EQUIPMENT

- 12.2.1 The equipment shall provide access and connection facilities for the individual testing of all relay sets and circuit packages. These facilities shall be mounted on or adjacent to the circuit package so that they are available without the need to remove the cover from the package. Each traffic circuit shall be provided with an access or monitor jack, an occupation lamp or its equivalent and a busy key or control. These facilities are described in Clauses 12.2.2 to 12.2.4. In addition, each exchange line and bothway dialling tie line shall be provided with a break test jack (See Clause 12.2.5). Multiple and battery jack requirements are stated in Clauses 12.2.6 and 12.2.7.
- 12.2.2 Access or Monitor Jack The access or monitor jack shall be a bridging test jack connected on the extension side of the transmission bridge to allow monitoring and facility testing of the circuit.
- 12.2.3 Occupation Lamp The occupation lamp or its equivalent shall indicate when the circuit is occupied by a call. This lamp may be under the control of a key.
- 12.2.4 Busy Key The busy key or control shall when operated, cause outgoing circuits to be unavailable for seizure and operate supervisory lamps on operators positions to indicate that the circuit is unavailable. Such a key or control shall also provide backbusing or blocking of incoming exchange line circuits.
- 12.2.5 Break Test Jack The break test jack shall be wired in the exchange or tie line path to provide for testing into the PABX line circuit with isolation from the public exchange of distant PABX.
- 12.2.6 Multiple Jacks Jacks shall be provided and wired on each rack and frame for multiple connection to form inter-rack and frame test circuits. Two multiple testing circuits are required.
- 12.2.7 Battery Jack A battery jack, protected by a 3 ampere fuse, shall be provided on each rack and frame, Where two or more suites of racks may be installed, wiring shall be provided so that a lamp may be provided in a prominent position within the PABX room to glow when a plug is inserted in any of the battery jacks.

12.3 TESTING EQUIPMENT

- 12.3.1 Testing equipment shall be provided for functional switching, signalling and transmission checks and to help maintenance staff locate faults. Functional testing equipment is specified in Clause 12.3.2 and fault location aids in Clauses 12.3.3 to 12.3.6. The items covered by these clauses may be combined into one test set.

- 12.3.2 Functional Test Sets and Automatic Circuit Routiners Functional test sets shall be housed so that they can be conveniently used at, or near, each circuit to be tested. Automatic circuit routiners shall be controlled from a service control centre in the PABX and shall provide switched access to all circuits. A permanent print out of circuit identification and test result shall be provided. These devices shall at least provide the following:
- Access Means for connecting to and from each functional circuit.
 - Busy Indication An indication of the state of occupancy of the circuit under test.
 - Pick-up Simulation of pick-up of the circuit under limit conditions.
 - Input Signals Simulation of input signals to the circuit under limit conditions.
 - Output Signal Check A means to receive and gauge the adequacy of the circuit output signals under limit conditions. Stored address information in the circuit is to be indicated.
 - Monitoring Monitoring of service tones and the absence of crosstalk or noise.
 - Transmission A through transmission test at between 800 and 820 Hz to gauge the insertion loss of the circuit.
 - Balance A longitudinal transmission path test at between 800 and 820 Hz to gauge the leg to leg balance and balance to earth of the circuit.
 - Operation A test of each operational feature of the circuit.
- 12.3.3 Common Control Monitoring Set This equipment shall indicate stages in the equipment operation by the monitoring of selected calls. The successive switching functions shall be shown by a display which will continue until completion of a switching sequence and the release of the common control equipment. Connection of the set shall not interfere with the normal operation of the PABX. The set shall provide the option of monitoring all or any particular type of switching operation. Provision shall be made for a display to be held or a record retained after the release of the common control equipment and its continuing in normal operation. It shall be possible to select from any release condition or only abnormal release conditions to produce the display holding or recording condition. A feature is required which will permit a detailed examination of the state of operation of components (e.g. relays) within the common control equipment when release conditions of a selected type are experienced. It is desirable that this be achieved by transferring the detailed information to a lampset or other permanent display. When it is achieved by means of a lockup of common control equipment, operation of the facility is to produce an alarm or a timed self reset. It shall be possible to select for examination any release mode, e.g., normal release, forced release due to timeout, release due to failure to identify the calling extension. A further feature shall provide for the selection of a particular failure mode.
- 12.3.4 Call Routing Indicator This equipment shall indicate the path through the exchange of a call being monitored. The indication may be in the form of a test set display or other record showing information such as switching matrix path, register, enquiry circuit, connecting circuit, exchange line circuit. Alternatively, it may be a visual signal on the items of equipment occupied by the call.
- 12.3.5 Forced Traffic Facility This facility enables test traffic to be forced into a chosen path. This involves the direction of calls to a selected register, connecting circuit, enquiry circuit, exchange line, etc., without the need to busy all other available devices of the same type.
- 12.3.6 Supervision of Circuit Packages It shall be possible to supervise the condition of circuit packages whilst they are connected in their normal positions and in normal operation. Where the state of the switching components cannot be observed directly, a monitoring attachment must be provided.
- 12.3.7 Physical Design of Testing Equipment Small and portable testing equipment weighing less than 10 Kg is preferred. For small PABXs to Feature Lists A and B where the testing equipment will be used at a number of locations this restriction on weight and size is mandatory. The testing equipment shall be suitably housed to allow transport by hand or by truck without damage.

12.4 FAULT RECORDERS

12.4.1 Fault recorders shall be automatically called in by the equipment control circuits to permanently record the failure of any switching function to mature within its stipulated time. The details of line faults shall also be recorded before the line is reverted to line lock-out. The fault recorder read-out shall facilitate qualitative maintenance by simplifying sorting of similar failures and diagnosis of the source of the troubles. It shall give the following information:

The time and date of the failure.

The identification of the control circuit that reported the failure.

The identification of the circuits and switching paths involved with the failure.

The nature of the failure including, if practicable, the circuit elements involved.

Alarm conditions in accordance with Clause 12.5 for repeated failures of the same kind that indicate a failure of a route, stage, group of extensions, or operational feature.

12.4.2 Fault recorders are required for PABX types capable of development to over 1,000 extensions. Where provided, this equipment may replace the test sets as detailed in paragraph 12.3.2.

This type of equipment is regarded by the APO as highly desirable for all PABXs to Feature List C. See also Clause 12.6.7 which specifies the APO's preference for remote operation of fault recorders at a centralised maintenance centre.

12.4.3 Service Control Features Facilities shall be provided on all PABXs to count for each marker or equivalent device:

The total number of calls offered.

The number of lost calls (faults and congestion).

In addition the following facilities shall be provided on PABXs to Feature List C:

For each marker - Separate circuit leads for each traffic route classification listed in Clause 5.2.1. to indicate the total number of calls offered and the number of lost calls.

For the installation - Control circuitry for the connection of any of the marker leads to a meter set. This shall count offered and lost calls to each traffic route classification listed in Clause 5.2.1. The control circuitry shall provide modes for use, one at a time to count total and lost calls for every classification simultaneously within any one marker or each individual classification simultaneously within every marker.

The meters shall be four or five digit types. Those permanently connected to each marker shall not be zero reset types, but the classification meters may be types capable of being manually restored to zero.

12.4.4 Service Alarm For PABXs to Feature Lists B and C, an urgent alarm shall be given when the ratio of malfunctions, time-outs and congestion to the total calls handled by the PABX or marker, rises above a predetermined level. The counting device shall be adjustable to vary the ratio from 1 in 5 to 1 in 500.

12.5 ALARMS

12.5.1 Circuitry must include alarms to simplify the location of faulty units particularly in critical circuits. A summary of alarm requirements is contained in Table 18.

TABLE 18

SUMMARY OF ALARMS

Classification	Type of Alarm
URGENT Red Lamp and if PABX staffed audible alarm	Fuse Low volts Power supply failure (output) Ring and tones failure Marker Service
NON-URGENT Blue lamp	Power fail (mains) High volts Ring and tones changeover Marker changeover
SUPERVISORY White lamp	Abnormal line condition

12.5.2 Alarm Classifications PABX alarms are classified as:

Urgent when an equipment fault or other defect causes failure of a route, stage, group of extensions or operational feature.

Non-urgent when a failure of the equipment is of such a nature as to cause little or no disruption to traffic or features.

Supervisory when a line or termination condition external to the PABX, causes the particular extension, exchange or tie line to be faulty or otherwise not available for traffic.

12.5.3 Precedence of Alarms An urgent alarm shall take precedence over non-urgent and supervisory, and a non-urgent shall take precedence over a supervisory in determining the effective alarm condition.

12.5.4 The alarm circuitry shall be highly reliable. A failure or abnormal operation of an alarm circuit shall result in an alarm.

12.5.5 Separate power supplies for alarm circuits will not be necessary, but a failure of the alarm circuit power should operate an urgent alarm except when it is due to the electrical supply mains failure as indicated in Clause 12.5.19.

12.5.6 Resetting Alarms Urgent alarms shall be reset only by the manual operation of the control at the PABX equipment. Non-urgent and supervisory alarms shall be self-restoring.

12.5.7 Alarm Displays Alarms shall be displayed so that the location of the equipment failure may be quickly found. The main alarm displays shall be in the PABX equipment room and on the operators position.

Urgent An urgent alarm shall light red lamps and operate a bell or buzzer in the PABX room whilst it is attended except when a complete power failure occurs. The bell or buzzer shall be provided with a control mounted on the equipment such that when the control is operated, the bell or buzzer is inoperative during an alarm condition but operates when the condition which causes the alarm restores.

Non-urgent A non-urgent alarm shall light blue lamps except that an interruption to the electricity supply mains shall be indicated by the absence of glow from a neon lamp mounted on or adjacent to, the battery eliminator or rectifier.

Supervisory A supervisory alarm shall light white lamps.

12.5.8 Alarm Extension PABXs to Feature Lists B and C shall be capable of extending to the public exchange or service centre on a circuit provided by the APO, urgent and non-urgent alarm classifications. The extended alarm circuit shall connect to a conductor and shall normally provide the following circuit conditions:

No alarm - 6,800 ohms (± 10 per cent) to earth.

Urgent alarm - an open circuit.

Non-urgent alarm - a short circuit to earth.

- 12.5.9 Alarm Test Features shall be incorporated in each alarm system.
- 12.5.10 Urgent Alarms Conditions which cause the operation of the urgent alarm are described in Clauses 12.5.11 to 12.5.16.
- 12.5.11 Fuse The operation of any protection isolation device, provided in accordance with Clause 11.2.2 shall operate an urgent alarm.
- 12.5.12 Low Volts The output at any battery power supply falling below $1.92n$ volts, where n is the number of cells, shall operate an urgent alarm.
- 12.5.13 Power Supply Failure The output of a battery eliminator or auxiliary voltage supply that falls below its minimum specified voltage shall operate an urgent alarm, however, if the cause of the condition is an interruption to the electrical supply mains other than by an alarmed isolation device, only the non-urgent alarm shall be operated.
- 12.5.14 Ring and Tone Failure The failure of a common service to supply the equipment shall immediately operate an urgent alarm.
- 12.5.15 Marker The failure of a traffic control device, except where a duplicate continues to function correctly, shall operate an urgent alarm.
- 12.5.16 Service Alarm conditions emanating from fault recorders, service control and remote control equipment shall operate an urgent alarm.
- 12.5.17 Non-urgent Alarms Conditions which cause the operation of the non-urgent alarm are described in Clauses 12.5.18 to 12.5.21.
- 12.5.18 Power Fail Interruption of the electricity supply mains to any power converter shall, unless it is due to the operation of an isolation device alarmed in accordance with Clause 12.5.12, operate a non-urgent alarm.
- 12.5.19 High Volts The output of a battery eliminator or auxiliary voltage supply that rises above its specified maximum voltage shall operate a non-urgent alarm.
- 12.5.20 Ring and Tone Failure - Change-over effected The automatic change-over to a duplicate common service supply, e.g. ring and tone outputs, shall operate a non-urgent alarm.
- 12.5.21 Marker Change-over Effected The failure of a traffic control device, when a duplicate continues to function correctly shall operate a non-urgent alarm.
- 12.5.22 Supervisory Alarms Abnormal electrical conditions of extension lines, exchange lines or tie lines, that would result in ineffective holding of common switching paths, incorrect operation of the equipment, or failure of calls over such lines, shall operate supervisory alarms.

12.6 CENTRALISED MAINTENANCE REQUIREMENTS

- 12.6.1 Extension Test Facilities The extension test facility, shall provide for individual testing of the extension line and telephone (including dial and pushbuttons) from the public exchange or service centre. The test circuit is made free of all electrical bridges and other circuit elements across the line or connected to earth. It is necessary to gain access to, and test the extension line under any fault condition. The extension test facility is mandatory on all PABX sizes and types and shall cater for the procedures set out in Clauses 12.6.2 to 12.6.5.
- 12.6.2 The testing officer at the APO service centre will gain access to the test line when it is free of traffic, and initiate a ring-in call to the PABX. After answering, the PABX operator will connect the call to the telephone required for the test. The removal of electrical bridges etc., will than be achieved by the operation of a test line control key on the operators position which must be released at the conclusion of the test so as to restore the test connection and the exchange line to normal. A lamp indication shall be given when the test line control key is operated.

The test line control, when operated, shall ensure that the test line and connections are guarded from any intrusion, including from the operators positions and shall operate any exchange line engaged supervisory displays.

- 12.6.3 The test line control key function will be duplicated by a continuous earth potential applied to one conductor of a control pair from the parent exchange.
- 12.6.4 The testing officer at the APO service centre will gain access to an indialling test line, dial the extension number and be connected in the usual manner. The test line control function is then achieved by the application of a continuous earth potential to one conductor of a control pair from the parent exchange.
- 12.6.5 The repairman at any exchange access extension may call the PABX operator and request the test line to be reverted to him when it is available. The revertive call will be established in the normal manner and the test line control operated as in Clause 12.6.2.
- 12.6.6 An automatic answering circuit, connected to a spare extension line, shall be available at all PABXs to Feature List C with indialling. This answering circuit shall respond to automatic test calls generated by traffic route testers in public exchanges. The features offered by such an answering circuit shall be similar to those provided by the APO Drawing CE-20181.
- 12.6.7 Remote Print-out From Fault Recorder For PABX installations of 1000 extensions or more there is a need for closer surveillance of the switching equipment than is possible by the indication of alarms as specified in Clause 12.5. The objective is remote supervision equipment similar to the Automatic Disturbance Recorder (ADR) now under development for large public exchanges. It is intended to send information over a telegraph or data channel to operate a standard teleprinter. Print-outs are to include those already specified in Clause 12.4.1.

12.7 TRAFFIC MEASURING

- 12.7.1 Traffic measuring leads shall be provided for each internal and external traffic path and for each common control device.
- 12.7.2 The number of traffic leads provided from each device shall be determined by the number of individual, unidirectional traffic routes to which the device has access. Typical examples are:
- Bothway exchange and tie line circuits shall provide two traffic leads, one for outgoing traffic and the other for incoming traffic.
- Indialling exchange line circuits shall indicate separately, traffic to the PABX operators, and calls direct to extension lines.
- 12.7.3 The occupied or unavailable circuit condition is indicated by the connection of earth to the traffic measuring lead via a 100 K ohm traffic measuring resistor. The earth potential shall be the same as the earthed plate of the 50 volt DC power supply used by the traffic measuring equipment. The occupancy signal shall be continuous during the holding period of the device and be arranged to record the total holding time including the circuit guard time.
- The 100 K ohm traffic measuring resistors shall be a type approved by the APO. They shall be $\frac{1}{2}$ watt rating and within $\pm 1\%$ accuracy. The average value of a random sample shall be within $\pm 0.5\%$ of nominal. The resistors shall be provided as part of the PABX equipment.
- 12.7.4 The unoccupied and available condition is indicated by an open circuit on the traffic lead to the measuring equipment.
- 12.7.5 The switching contact or element used to signal traffic occupancy shall be used exclusively for that purpose.
- 12.7.6 The traffic measuring leads for each suite of the PABX equipment shall be connected to a 200 point jack or jacks, mounted at a convenient location within the suite. The type of jack used shall be a knife jack in accordance with APO Drawing CE-64001 Sheet 1 or similar type. A chart shall be provided showing the allocation of traffic measuring leads in each jack.
- 12.7.7 When a PABX consists of more than one suite, tie cables shall be provided to permit connection of the selected measuring groups to a single terminating point from which they will be cross-connected by jumpering to the traffic measuring equipment. Tie cables shall terminate on the suite jacks and be provided on the basis of 40 wires per 200 point jack. Measuring groups will be formed by strapping on the 200 point suite plugs.

SECTION 13. DOCUMENTATION

13.1 GENERAL

13.1.1 A set of instructions and drawings for installation, operation and maintenance shall be provided for each PABX. Instructions and drawings shall be exclusively in the English language. Terms and expressions that are unique to a particular country, manufacturer or PABX shall be defined. Documentation distribution requirements are contained in APO Specification 1071. Documents supplied shall be capable of inclusion with minimum effort in the standard APO documentation system. To simplify the integration of PABX documentation into the APO documentation system, technical descriptions and instructions shall be printed on paper cut to size A4 of ISO Recommendation R216.

13.1.2 Printing Instructions and drawings, including the manufacturer's handbooks when supplied, shall be prepared by a good quality printing or duplicating process with dyeline prints. Carbon copies are not acceptable. Photo-reductions of drawings to suit instruction sheet dimensions will be acceptable provided that detail necessary for installation and maintenance is not impaired. Photographs shall be produced as screened half tone reproductions of the originals.

13.1.3 Cover Each set of technical instructions and drawings shall be in loose leaf covers, capable of opening flat. The cover shall be made of leather-board, fibreboard or equivalent material and shall be fitted with snap ring binders. The spine of each cover shall be designated as to the information contained therein. The covers shall be suitable to hold sheets to a thickness of:

minimum - 25 mm (1 inch)

maximum - 40 mm (1½ inch)

13.1.4 Technical instructions shall include relay data, circuit descriptions, circuit aid charts, etc., and technical information covering maintenance operations and adjustments for all special or proprietary components. Manufacturer's handbooks may be included as part of the instructions, provided that the wording of the handbooks is in the English language and the dimensions of the handbook sheets, and of drawings when folded, are uniform with those of the instruction sheets.

13.1.5 Index When the technical instructions and drawings are contained in more than one cover, a table of contents shall be provided at the front of the first cover of the series. The table of contents shall indicate how the technical instructions and drawings are grouped in the various covers.

A detailed list of the contents shall be included at the front of each cover. When the pages run in sequence, these numbers shall be used as points of reference in the table of contents. When the pages of the document are not numbered sequentially or sections are difficult to locate, the commencement of each section, chapter or group of drawings, etc. shall be indicated by a projecting tab. The tab shall be designated and referenced in the table of contents.

13.1.6 Modified Circuits When an approved modification is made to any part of the PABX, the issue of the drawing, circuit description, sequence diagram, etc., shall be raised to include the modification. Copies of the new issue of the drawings, revised description, sequence diagram, etc., shall be included in the PABX documentation and the pre-modification issue removed.

13.2 GENERAL DESCRIPTION

13.2.1 A general description of the PABX shall be provided as an introduction to the equipment. The general description shall include the requirements of 13.2.2 to 13.2.8.

13.2.2 PABX Capacity The PABX line and traffic capacity shall cover the stages of development from the minimum size to a fully equipped installation.

13.2.3 Numbering Scheme Details of the extension numbering scheme and the dialling codes for all features shall be given. When the numbering scheme is flexible, the numbering and codes proposed for common use in Australia shall be given major emphasis, minor emphasis being given to the possible variations.

13.2.4 Equipment and Components The type and size of equipment racks, and rack and suite layouts shall be given for each stage of development. Components included in the PABX which are not standard APO items shall be fully described including details of types, nomenclature, method of operation and of characteristics.

- 13.2.5 Operational Features The operational features of the PABX shall be listed and described in accordance with the terminology of Section 2 of this specification.
- 13.2.6 Trunking and Function of Devices A block diagram or diagrams shall be provided together with a simple sequential description of each type of call or feature. Each circuit package or functional unit shall be listed and its function described.
- 13.2.7 Operators Position A face layout diagram of the operators position with lamps, keys and other indicating or control devices, labelled with their designations, shall be provided. Signalling, control and connecting devices on the operators position shall be listed and their functions described. The operating procedure for each type of operator controlled call or feature shall be described in sequence, listing each step, the signals received and the control or connecting devices operated.
- 13.2.8 Power Supply, and Ring and Tone Equipment The power, and ring and tone supply arrangements for the PABX shall be described together with the details of any emergency standby provision for low voltage or power fail operation of the system.

13.3 CIRCUIT DESCRIPTIONS

- 13.3.1 A sequential description of each type of call and operational feature shall be provided. The operation of each relay or equivalent component shall be described in sequence, its mode of operation being detailed if such is not readily apparent. In the case of large systems which consist of several separate switching stages, each responding to a separate common control device, each stage may be described as a separate entity providing that the interworking between stages is fully described in sequence. The descriptions shall include the requirements of Clauses 13.3.2 to 13.3.6.
- 13.3.2 Headings Each operational stage shall be given a heading so that the description can be picked up at a convenient point during maintenance activities. The headings should relate to the stages in the simple sequential description which was given as part of the introduction to the system (see Clause 13.2.6).
- 13.3.3 Circuit References Throughout the circuit descriptions, cross reference shall be made to the number(s) of the circuit drawing and sheet to which the description refers.
- 13.3.4 Sequence Charts Sequence charts shall be provided as a supplementary aid to the circuit descriptions. The sequence charts shall be included in the set of instructions in such a way that the circuit description can be read and the sequence chart used without the need to turn pages. Sequence charts on fold out pages are satisfactory. The conventions used in the presentation of sequence charts shall be explained in the technical instructions.
- 13.3.5 Relay Functions A list of the relays or other equivalent components shall be provided for each relay set or equivalent. The function of the components so listed shall be provided.
- 13.3.6 Lamps, Jacks, Keys etc. The function of lamps, jacks, keys and other manually operated controls not part of the operators positions, shall be defined.

13.4 DRAWINGS

- 13.4.1 An indexed set of circuit drawings covering all aspects of the PABX, including circuit packages and rack wiring, shall be provided. The circuit drawings shall meet the requirements of Clauses 13.4.2 to 13.4.8.
- 13.4.2 Drawing Methods The circuit drawings shall be of the schematic type using the associated contact principle or a co-ordinated system of a detached contact type with a reference key for all relays, their contacts and other major components. The layout of such drawings shall be neat and orderly and only symbols in accordance with APO Engineering Instruction DRAFTING Symbols, Section 14, shall be used unless an explanatory code defining any other symbols is included on the sheet on which the symbol is used.
- 13.4.3 Survey Diagrams Survey diagrams giving an appreciation of the complete PABX shall be provided. The survey diagrams need not supply interconnection details between relay sets nor complete circuit details, but should consist of various circuits, combined, simplified and abbreviated to supply sufficient information to understand the fundamental operation of the PABX.
- 13.4.4 Test Voltages and Wave Shapes When understanding a circuit or fault diagnosis would be simplified by the indication of voltage or current values or wave forms, these shall be shown on circuit drawings adjacent to various points.

13.4.5 Functional Circuit Drawings Functional circuit drawings shall be provided to give detailed information concerning the connections between circuit elements involved in a particular circuit function.

13.4.6 Titles Titles of drawings shall indicate the contents and purpose of the drawing. Only abbreviations which are obvious to non-specialist technical staff, or are explained in the table of contents or technical instructions shall be used.

13.4.7 Method of Filing Drawings which are not included in a cover with the instructions shall be folded to a size of approximately 200 mm x 300 mm (8 inches x 13 inches) and shall be stamped with an index number on the lower left or upper right corner of each sheet so that it is visible without the need to unfold drawings. Each set of unbound drawings shall be contained in a folder or pouch of plastic or similar material.

Drawings which are bound with the instructions or directly associated with the text, shall open up clear of the instructions so that the whole drawing can be viewed while the text is being read.

When folded, such drawings shall be of the same dimensions as those of the instruction sheets.

13.4.8 Maximum Drawing Size The size of drawings shall not exceed 1015 x 760 millimeters (40 inches x 30 inches).

13.5 INSTALLATION INFORMATION

13.5.1 The documentation shall include information to cover the installation and commissioning of the PABX by installers who have not had previous experience or training on the equipment. The information shall include:

Recommended floor layouts.

Methods of assembling and erecting racks and superstructures.

Details of inter-rack cabling and cable accommodation.

Rack interconnection details.

Power, common services and alarm distribution details.

Special installation techniques.

Use of special installation tools or jigs.

Pre-commissioning test procedures.

Installation quality levels.

13.6 MAINTENANCE INFORMATION

13.6.1 Maintenance aspects of the PABX shall be explained in sufficient detail to permit performance of this work by non-specialist technical staff. The information supplied under this heading shall include the items covered by Clauses 13.6.2 to 13.6.12.

13.6.2 Technical Data The technical data of each dynamic (mechanical and electrical) component shall include the characteristics and tolerances of the component that are relevant to the functions it is to perform.

13.6.3 Circuit Symbols and Contact Numbering When circuit symbols and contact numbering vary from APO standards, details shall be provided.

13.6.4 Terminal Numbering The method of numbering connection points shall be explained.

13.6.5 Call Tracing Methods of tracing calls shall be explained.

13.6.6 Alarms The display provided to indicate each type of alarm shall be explained together with details of the fault condition causing the alarm, a guide to locating the faulty circuit, what the extended alarm condition is, and how to reset the alarm circuit if such is necessary. Information on alarms shall be given in charts.

- 13.6.7 Busying or Blocking of Devices The method of busying or blocking circuit elements in the case of faults or during fault diagnosis shall be explained.
- 13.6.8 Test Sets and Maintenance Aids The application and operation of test sets and maintenance aids shall be described.
- 13.6.9 Fault Diagnosis and Location The preferred method of fault diagnosis, location and repair shall be explained. See also Clause 13.4.4.
- 13.6.10 Adjustments Instructions shall be provided on the adjustment of mechanical and electro-mechanical components used in the PABX. Details shall be given of the application and method of using tools and instruments required for this work.
- 13.6.11 Service Routines Service routines for the PABX shall be described and the periodicity of such routines stated.
- 13.6.12 Special Tools and Instruments Special tools and instruments that are required for purposes other than adjustment of components shall have their method of use and any necessary precautions for their use described.

13.7 OPERATING INSTRUCTIONS

- 13.7.1 Operators The operators instructions shall be in a loose leaf handbook and shall describe the operating features of the operators position and the procedures for handling all types of calls, see (Clause 13.2.7). The handbook cover shall be made of leatherboard, plastic or cardboard. The preferred dimensions of the cover and instructions are 210 mm × 148 mm (8 $\frac{1}{4}$ inches × 5 $\frac{3}{4}$ inches) i.e. ISO Recommendation R216 Size A5. The instructions shall be printed on good quality paper to provide a reasonable life with constant use. The printing shall be as specified in Clause 13.1.2.
- 13.7.2 Extension Users The extension users instruction shall be in the form of a simple handbook or instruction of approximate dimensions 210 mm × 148 mm (8 $\frac{1}{4}$ inches × 5 $\frac{3}{4}$ inches) and shall set out the method of using the features available. The instructions shall be printed on good quality paper or card to permit frequent use, and the printing shall be as specified in 13.1.2

SECTION 14. ASSOCIATED REFERENCES

14.1 REFERENCES

14.1.1 The whole, or relevant parts as indicated, of the undernoted drawings, specifications and engineering instructions form part of this specification but in the event of any discrepancy between them and this specification, the latter shall be followed.

14.1.2 APO Specifications

<u>Number</u>	<u>Title</u>
876	Regulated Smoothed Power Supply Rectifiers Output 24 or 48V DC 50A max.
975	Arresters - Moulded Gas Filled and Silicon Carbide types.
1039	Quick Connect Terminal Studs and Cord Tags.
1041	Foot, Non-slip, FNS-1.
1053	Attachment of Equipment to the APO Switched Telephone Network - Technical Conditions.
1071	PABX Equipment - Supply and Installation.
1078	Australian Inter-Exchange Signalling Systems.
1081	PABX Equipment Approval Testing.
1102	Colour Codes for Alarm Lamps and Cables Used in Telecommunication Power Plant.
1104	Audible Signals for the Australian Telephone Network - Statement of Planning Objectives.
1105	Signalling on Subscribers Lines.

14.1.3 British Standards

<u>Number</u>	<u>Title</u>
BS2488	Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunication equipment.

14.1.4 Australian Standards

<u>Number</u>	<u>Title</u>
AS CCI	Part 1 - Wiring Methods. Part 2 - Materials.
AS C333	Basic Climatic and mechanical Robustness Tests for Components for Telecommunication and Allied Electronic Equipment.

14.1.5 American Society for Testing and Materials

<u>Number</u>	<u>Title</u>
ASTM D626	Fire Retardent Properties of Treated Textile Fabrics.
ASTM D635	Test for Flammability of Rigid Plastics over 0.127 cm (0.050") inch in thickness.

14.1.6 APO Engineering Instructions

Drafting, Symbols. S0100, S0110, S0200, S0210, S0220, S0230, S0240, S0250, S0260, S0270, S0280, S0290, S0300, S0310, S0320, S0350, S0370, S0380, S0390, S0410.

Planning, Traffic K0100

Telephone, Substation, A0010

Telephone, Substation Z0006 (Interim)

Technicians Handbook, Subscribers Equipment Installation Diagrams.

14.1.7 APO Glossaries

Planning, T0010, Traffic and Trunking Terms.

14.1.8 APO Drawings

<u>Number</u>	<u>Title</u>
CE 250	Switchboard CB PBX Lamp Signalling - Cord Type
CE 11029	Switchboard CB Cordless
CE 11239	Switchboard PMBX No. 2/2A
CE 11240	Switchboard PMBX No. 2/3A
CE 20181	Tone Answer Relay Set
CE 64001 Sheet 1	Miscellaneous Sub-assemblies for Crossbar Racks.

14.1.9 The International Telegraph and Telephone Consultative Committee (CCITT)

White Book, Volume 11A, Recommendation E161.

White Book, Volume VIII, Recommendation V55.

SECTION 15. GENERAL

15.1 CHANGES TO ISSUE 1

- 15.1.1 The main changes between Issue 1 and Issue 2 of this specification are set out in Clauses 15.1.2 to 15.1.16.
- 15.1.2 The format of the specification has been changed.
- 15.1.3 The facilities list has been rationalised into feature lists for PABXs of different sizes.
- 15.1.4 A limited feature PABX has been specified.
- 15.1.5 Conditions for the use of link-connected operators positions have been included.
- 15.1.6 PABXs suitable for installation in open office space have been introduced.
- 15.1.7 There has been an increased emphasis on reliability and maintainability and less on detailed specification of hardware.
- 15.1.8 There has been a more flexible approach to PABX traffic capacity.
- 15.1.9 Reference equivalent requirements have been included in the Transmission section.
- 15.1.10 Transmission requirements when an operator intrudes on an exchange call have been relaxed.
- 15.1.11 Return loss requirements have been tightened.
- 15.1.12 Extension line transmission and signalling limits have been specified.
- 15.1.13 First party release of PABX equipment has been adopted for internal calls.
- 15.1.14 Voice frequency signalling objectives have been included.
- 15.1.15 Maintenance features have been further detailed.
- 15.1.16 Test methods have been extracted and included in APO Specification No. 1081.

END OF SPECIFICATION.

APPENDIX 1

MEETING OF CALLS ON BOTHWAY CIRCUITS

GENERAL.

Meeting of calls is said to occur when calls from two exchanges are connected to the same bothway circuit within the risk time. The risk time is here defined as the interval of time between seizure of a bothway relay set at one end of the circuit and the blocking of the corresponding relay set at the other end of the circuit. Depending on the switching arrangements, one or both calls colliding on the same bothway circuit during the risk time will be lost.

It is intuitively apparent that the probability of two calls seizing the same bothway circuit in a group must depend on the following factors:-

- (a) The number of bothway circuits in the route.
- (b) The traffic offered to bothway circuits.
- (c) The method of hunting.
- (d) The risk time.
- (e) The call holding time.

A quantitative analysis of the call collision probability as a function of the above listed factors is given in the following paragraphs. In all cases, the following assumptions apply:-

- (a) calls arrive individually and collectively at random,
- (b) calls which fail to get a free circuit for whatever reason are lost and removed from the system,
- (c) full availability conditions apply at both ends of the route,
- (d) all circuits in the route are bothway,
- (e) at each end of the route, calls are set up one at a time.

DEFINITION OF SYMBOLS.

- n = number of bothway circuits between exchanges X and Y,
- A_y = traffic offered to bothway circuit group from exchange Y,
- A = total traffic offered to bothway circuit group ($A_y + A_x$),
- h = average call holding time,
- T = risk time (assumed constant),
- e = base of natural logarithms.

RANDOM HUNTING CASE.

Assume that while p of the n circuits in the route are engaged, another circuit is seized (but as yet unguarded) by a call just arrived from exchange X. Let k attempts be made from exchange Y to seize a circuit during the risk time T . What is the probability that a call from Y will not test the circuit seized at X?

Since the hunting is random and each circuit has an equal chance of being tested, the above probability is given by

$$\frac{\binom{n-p-1}{k}}{\binom{n-p}{k}} = 1 - k/(n-p) \quad \dots(1)$$

The numerator of the left side of above expression gives the number of ways of making k randomly distributed seizure attempts over $(n-p-1)$ free circuits, which exclude the one just seized from exchange X. The denominator gives the number of ways of making k randomly distributed attempts over all $(n-p)$ free or unguarded circuits.

Now the probability that one of the k attempted seizures will fall on the circuit just engaged from X is the complement of (1). That is, this probability is

$$k/(n - p) \quad \dots(2)$$

From this we deduce that the average probability of a double seizure when there are n - p free circuits in the route is

$$DSP(n - p) = \frac{1}{n - p} \sum_{k=0}^{\text{Limit}} k P(k) \quad \dots(3)$$

where P(k) is the probability of k randomly distributed seizure attempts from Y exchange during the risk time T. Since calls arrive at Y at random, the precise number which will arrive during the risk time T is a Poisson-distributed variable with average

$$\bar{k} = A_y T/h \quad \dots(4)$$

Hence the probability of k seizures during T is

$$P(k) = \frac{(\bar{k})^k \cdot e^{-\bar{k}}}{k!} \quad \dots(5)$$

The upper limit of the sum in equation (3) depends on the method of connecting calls to the route. For example, k cannot exceed the number of markers in exchange Y or n - p, whichever is the lesser. If, for simplicity's sake, we use the fact that P(k) is very small for large k and sum from k = 0 to k = ∞, equation (3) reduces to the following:-

$$DSP(n - p) = \bar{k}/(n - p) \quad \dots(6)$$

In view of what has been said previously, the extension of the upper limit to infinity means that equation (6) over-estimates double seizure probability. However, for practical values of \bar{k} ($\bar{k} < 0.5$) the error is negligible, as only the first few terms in the sum of equation (3) are of any significance.

To get the overall double seizure probability we must sum (6) over all possible occupancy states on the route.

If P(p) is the probability of p circuits in the route being occupied, the overall double seizure probability is

$$\begin{aligned} DSP &= \sum_{p=0}^{n-1} P(p) \cdot \bar{k}/(n - p) \\ &= \bar{k} \sum_{p=0}^{n-1} P(p)/(n - p) \end{aligned} \quad \dots(7)$$

Note that while \bar{k} depends only on A_y , T and h, P(p) depends on the total traffic offered to the route, namely A.

The sum in equation (7) has been computed for a practical range of traffic and trunk values and is tabulated at the end of this Appendix. It will permit easy calculation of double seizure probabilities for any given value of \bar{k} . A few checks will convince the reader that on bothway routes between ARM's the DSP is negligibly small.

ESSENTIAL HUNTING FROM OPPOSITE DIRECTIONS.

In this case, the risk of call collision exists only when there is one free circuit left in the route. Hence the probability of double seizure will be given by the following product:-

$$DSP = \left(\text{Probability of finding } n - 1 \text{ trunks busy in the route.} \right) \times \left(\text{Probability of at least one call arriving from Y during risk period.} \right)$$

$$DSP = \frac{n}{A} E_{1,n}(A) \cdot \sum_{k=1}^{\infty} P(k) \quad \dots(8)$$

$E_{1,n}(A)$ being the Erlang Loss probability.. $P(k)$ has been previously given by equation (5). Hence we can write

$$\sum_{k=1}^{\infty} P(k) = \sum_{k=0}^{\infty} P(k) - P(0) = 1 - e^{-\bar{k}} \quad \dots(9)$$

Finally, substitution for $\sum_{k=1}^{\infty} P(k)$ in equation (8) gives

$$DSP = \frac{n}{A} \left[(1 - e^{-\bar{k}}) E_{1,n}(A) \right] \quad \dots(10)$$

SEQUENTIAL HUNTING IN THE SAME DIRECTION AT BOTH ENDS.

In this case the first free circuit reached from one end of the route is also the first free circuit reached from the other end of the route.

The risk of double seizure is, therefore, defined by the probability of two successive calls, coming from opposite directions, arriving within the risk time and is quite independent of the total number of free circuits.

We can also pose the problem in the following manner: having seized a free circuit from exchange X, what is the probability of at least one call being offered within the risk time from the Y end of the route?

The probability of seizing a free trunk from exchange X is equal to the probability of there being at least one free trunk in the route. Under the assumptions stated on page 1 of this Appendix, this probability is

$$P_1 = 1 - E_{1,n}(A) \quad \dots(11)$$

The probability of one or more calls arriving at the Y end of the route has been derived for the previous case (equation (9)). Hence, the probability of call collision in this case is

$$DSP = \left[1 - E_{1,n}(A) \right] (1 - e^{-\bar{k}}) \quad \dots(12)$$

DEPENDENCE OF DSP ON THE METHOD OF HUNTING.

Examination of the three cases analysed shows that the double seizure probability is greatest when sequential hunting in the same direction is employed at both ends of a bothway group of trunks. On the other hand, when the same group of trunks is hunted sequentially, but in opposite directions from each end, the risk of call collision is a minimum. Hence, the obvious conclusion: where sequential hunting is employed, the hunting sequence at one end should be exactly opposite to that at the other end (i.e. 1, 2, 3, ...n at one end, n, n-1, n-2, ...2, 1 at the other).

With random hunting at both ends, the risk of double seizure is intermediate between the other two cases discussed above.

To illustrate the relative magnitude of the double seizure probability with the three hunting methods discussed, the following example is provided.

Example

Given	A = 6 erl
	A _y = 3 erl
	n = 12
	h = 120 secs
	T = 0.04 secs

The double seizure probabilities are as follows:-

Method of Hunting	DSP	Computed from:
Random	0.000020	Equation (7)
Sequential, opposite directions	0.000002	Equation (10)
Sequential, the same direction	0.000099	Equation (12)

Further illustration of the double seizure probability is provided in Fig. 1, where this probability is plotted as a function of the risk time. It will be understood that when some oneway circuits are provided instead of bothway circuits (all other conditions remaining the same), the double seizure probability will be smaller in all cases except where sequential hunting in opposite directions is employed. In the latter case, it will remain unchanged.

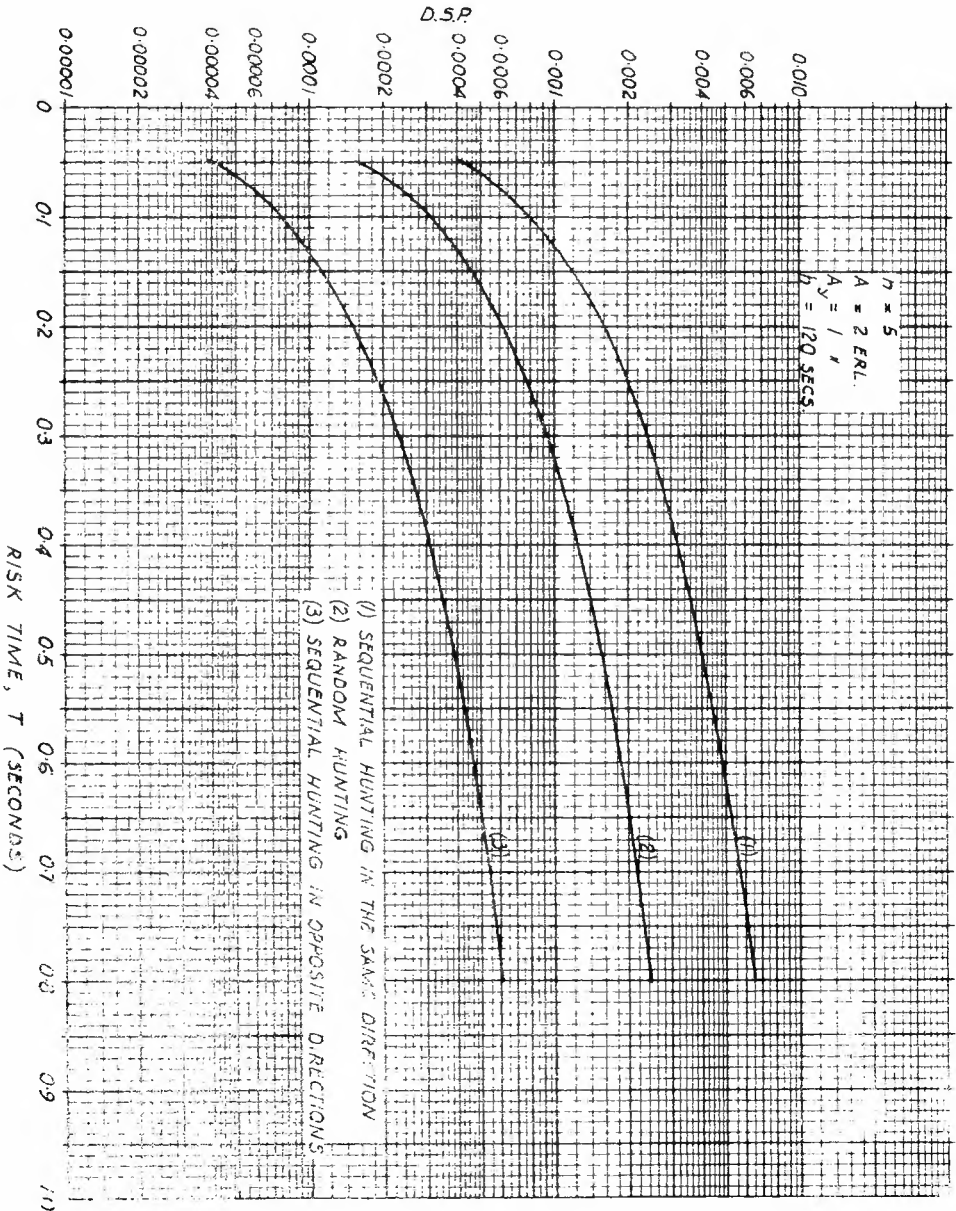


FIG. 1. DOUBLE SEIZURE PROBABILITY AS A FUNCTION OF RISK TIME.

TABLE 1

VALUE OF DSP/k IN ACCORDANCE WITH EQUATION (7)

NO. OF TRUNKS	TOTAL TRAFFIC OFFERED TO ROUTE									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1	0.50000	0.33333	0.25000	0.20000	0.16667	0.14286	0.12500	0.11111	0.10000	0.09091
2	0.60000	0.50000	0.41176	0.34615	0.29730	0.26000	0.23077	0.20732	0.18812	0.17213
3	0.50000	0.52632	0.48718	0.43662	0.38983	0.34973	0.31599	0.28760	0.26357	0.24305
4	0.36323	0.46429	0.48855	0.47330	0.44359	0.41037	0.37953	0.35101	0.32557	0.30303
5	0.27301	0.37156	0.43886	0.46345	0.46026	0.44327	0.42073	0.39680	0.37343	0.35148
6	0.21206	0.28701	0.36596	0.41991	0.44466	0.44835	0.43966	0.42457	0.40664	0.38788
7	0.17314	0.22409	0.29314	0.35878	0.40497	0.42960	0.43755	0.43453	0.42498	0.41188
8	0.00000	0.19087	0.23302	0.29513	0.35162	0.39270	0.41704	0.42772	0.42871	0.42338
9	0.00000	0.15127	0.18827	0.23905	0.29498	0.34489	0.38230	0.40624	0.41874	0.42265
10	0.00000	0.13025	0.15636	0.19458	0.24294	0.29369	0.33867	0.37329	0.39677	0.41050
11	0.00000	0.00000	0.11671	0.13703	0.16596	0.20366	0.24628	0.28959	0.32764	0.35822
12	0.00000	0.00000	0.00000	0.10544	0.12157	0.14398	0.17355	0.20909	0.24743	0.28481
13	0.00000	0.00000	0.00000	0.08620	0.09599	0.10902	0.12670	0.15010	0.17910	0.21215
14	0.00000	0.00000	0.00000	0.00000	0.07974	0.08798	0.09867	0.11286	0.13155	0.15513
15	0.00000	0.00000	0.00000	0.00000	0.00000	0.07412	0.08114	0.09003	0.10159	0.11667
16	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06524	0.07059
17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
19	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
30	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
35	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
45	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
50	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
55	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
60	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
65	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
70	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TABLE 1 CONTD.

NO. OF TRUCKS	TOTAL TRAFFIC OFFERED TO ROUTE													
	12.	14.	16.	18.	20.	25.	30.	35.	40.	45.	50.			
1	0.07692	0.06667	0.05882	0.05263	0.04762	0.03846	0.03226	0.02778	0.02439	0.02174	0.01961			
2	0.14706	0.12932	0.11379	0.10221	0.09276	0.07533	0.06341	0.05474	0.04816	0.04299	0.03882			
3	0.21001	0.18469	0.16472	0.14860	0.13532	0.11056	0.09342	0.08087	0.07129	0.06373	0.05762			
4	0.26536	0.23549	0.21141	0.19165	0.17519	0.14408	0.12226	0.10614	0.09376	0.08396	0.07600			
5	0.31269	0.28044	0.25364	0.23121	0.21226	0.17583	0.14989	0.13053	0.11557	0.10366	0.09397			
6	0.35160	0.31922	0.29121	0.26713	0.24640	0.20576	0.17627	0.15402	0.13669	0.12283	0.11150			
7	0.38171	0.35157	0.32388	0.29923	0.27749	0.23379	0.20136	0.17658	0.15712	0.14145	0.12860			
8	0.40274	0.37718	0.35145	0.32735	0.30540	0.25985	0.22513	0.19819	0.17682	0.15951	0.14524			
9	0.41451	0.39584	0.37371	0.35131	0.33000	0.28387	0.24752	0.21881	0.19579	0.17700	0.16143			
10	0.41704	0.40736	0.39045	0.37095	0.35115	0.30578	0.26849	0.23842	0.21400	0.19391	0.17715			
12	0.39586	0.40888	0.40685	0.39669	0.38257	0.34291	0.30599	0.27448	0.24807	0.22590	0.20715			
14	0.34592	0.38320	0.40025	0.40364	0.39873	0.37061	0.33724	0.30613	0.27887	0.25538	0.23517			
16	0.27997	0.33552	0.37208	0.39169	0.39900	0.38823	0.36179	0.33309	0.30622	0.28222	0.26110			
18	0.21370	0.27530	0.32653	0.36220	0.38345	0.39521	0.37924	0.35507	0.32993	0.30629	0.28486			
20	0.15913	0.21429	0.27088	0.31861	0.35332	0.39119	0.38914	0.37177	0.34978	0.32744	0.30634			
25	0.08538	0.10889	0.14404	0.18913	0.23767	0.33452	0.37884	0.38842	0.38110	0.36653	0.34934			
30	0.05812	0.06728	0.08084	0.10147	0.13114	0.23210	0.31925	0.36633	0.38350	0.38381	0.37550			
35	0.00000	0.04943	0.05565	0.06416	0.07648	0.13546	0.22683	0.30647	0.35447	0.37666	0.38272			
40	0.00000	0.00000	0.04301	0.04753	0.05333	0.07969	0.13843	0.22194	0.29553	0.34346	0.36901			
45	0.00000	0.00000	0.00000	0.00000	0.04151	0.05450	0.08276	0.14042	0.21743	0.28601	0.33334			
50	0.00000	0.00000	0.00000	0.00000	0.00000	0.04197	0.05581	0.08559	0.14172	0.21326	0.27760			
55	0.00000	0.00000	0.00000	0.00000	0.00000	0.03440	0.04248	0.05721	0.08812	0.14251	0.20940			
60	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03464	0.04305	0.05867	0.09035	0.14292			
65	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03491	0.04367	0.06014	0.09231			
70	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.02951	0.03519	0.04434	0.06160			

AMENDMENT TO APO SPECIFICATION 1080 ISSUE 2

CORRIGENDA AND ERRATA

Page 2 Contents: Section 9

Page number for 9.3 to 9.5 inclusive to read "47"

Page 5 Clause 1.2.7

After AL insert "(see Clause 2.1.3)", after BL insert "(see Clause 2.1.3)".

Page 6 Clause 2.2.14

To read as follows:

"A surveillance feature which records the originating address, part of the called address, the time and duration of a call."

Page 16 Clause 3.1.4

Delete words "to the caller".

Page 20 Clause 3.2.9

Add new sentence:

"Provision shall also be made to analyse at least 100 separate codes."

Page 26 Clause 3.4.15

Insert in first sentence after word batteries, "and PABX's designed to feature lists AL or BL"

Page 26 Clause 3.5.1

Last sentence to read:

"If the operators position is not provided.....attention."

Page 28 Clause 3.7.1

Last paragraph to read as follows:

"As a minimum requirement the call address recording equipment shall provide the same features as the APO Call Analyser - PETRA (details of which are contained in APO (Interim) Engineering Instruction, TELEPHONES, Substation 20006), except that the print out of called address information from call recorders shall be limited to the following:

Trunk Calls - the first seven digits only.

Local Calls - the first four or alternatively five digits (changeable option).

Note that this restriction on recorded digits applies only to Call Address Recording and not to Identified Outward Dialling."

Page 28 Clause 3.7.2

Delete first paragraph and replace with:

"Call Metering. If call metering is available, meters or other read out devices shall be rack mounted away from the equipment. Each meter must be identifiable with its extension."

Page 33 Clause 5.2.6

Add new sentence:

"The response time of the operator can be regarded as small and may be ignored."

Delete completely and insert the following:

"The mean holding time of PABX calls varies from installation to installation. For design purposes the following holding times should be assumed:

Class of Call	Operator Holding Time (seconds)	Total Holding Time (seconds)
Extension to Extension	-	60
Extension to Operator	15	20
Extension to Exchange dialled directly	-	140
Extension to Exchange reverted by operator	50	160
Exchange to Extension in-dialled	-	140
Exchange to Extension connected by operator	15	153

NOTE: Operator Holding time is the time the operators speech circuit is connected. Total Holding times include delay in answer."

Delete completely and substitute the following:

"The equipment shall satisfy the performance specifications of this document over an ambient room temperature range from +10 °C to +45 °C (still air) and relative humidity in the range 40 per cent to 70 per cent.

To cater for emergency conditions, such as the failure of air conditioning, the equipment shall perform its functions although not necessarily up to specification, and no permanent damage shall occur for a temperature range from 0 °C to 55 °C (still air) and relative humidity in the range from 20 per cent to 90 per cent."

Substitute "decaidc" for "decaidc" in first line, and add the following sentence:

"The distribution of total holding times and operator holding times can be assumed to follow the negative exponential law."

Third line delete word "offered" and insert "accepted".

Fourth line delete word "lost" and insert "Failed", replace last word with "congestion".

Add the following to the first paragraph:

"PABX types designed for open office space and for operation without an operators position shall have the main alarm displays mounted on the PABX equipment when no operators position is provided. This alarm display shall be visible at all times."