Bell Communications Research

Bellcore Practice
BR 201-510-001
Issue 1, December 1985

High-Level Generic Analysis Plan For Automatic Message Accounting Teleprocessing System (AMATPS) Collectors

Prepared by the Information Management Services Division
Bell Communications Research, Inc., December 1985.

For further information, please contact:

Bruno Ackerman
(201) 758-5276

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CONTENTS

1. Introduction

This document provides a high level, comprehensive analysis plan for determining whether an Automatic Message Accounting Teleprocessing System (AMATPS) Collector meets all pertinent Bellcore generic requirements. It assumes that the source of the requirements is Bellcore's *AMATPS Collector Generic Requirements*[1]. However, the analysis concepts can be used against supplier specifications, or against Bell Operating Company (BOC) acceptance standards as they apply to design, operation, reliability, security, and billing accuracy. Specific and detailed procedures to analyze a Collector against all Bellcore requirements listed in the above document[1] will be covered in future Bellcore documentation.

The Analysis Plan is divided into two sections: Section 2—*Tools and Facilities for Collector Analysis*, and Section 3—*Analysis Procedures*. Section 2 lists and describes the tools and facilities recommended to perform the analysis procedures detailed in Section 3.

2. Tools and Facilities for Collector Analysis

This section lists and describes the tools and facilities recommended to perform the Collector analysis procedures in Section 3.

Most tools and facilities described below refer to the pertinent analysis subsection in Section 3. In turn, these subsections are cross-referenced to the appropriate tool or facility in this section. Appendixes A and B list all cross-references between Sections 2 and 3.

2.1 Operational Switching System and AMAT

An operational switching system can provide billing data for an associated AMA Transmitter (AMAT) to transmit to the Collector being tested. The AMAT may use dial-up and dedicated lines operated at various transmission baud rates.

2.2 AMAT at Bellcore (Needed for Sections 3.5 and 3.6)

If it is not possible to use any facilities in Section 2.1, the AMAT at the Bellcore Billing Systems Technology Laboratory can provide test call billing records. This AMAT services a DMS-10M™ Switch (also located in this laboratory) with billing recording and is known as a Category A AMAT.

2.3 Collector at Bellcore (Needed for Sections 3.5 and 3.6)

If a malfunction occurs, the No. 1A Collector at the Billing Systems Technology Laboratory can poll the AMAT for billing data to verify whether it is malfunctioning or if the malfunction is in the Collector being analyzed.

2.4 Collector System Audit Counts and Summary Statistics (Needed for Sections 3.5, 3.6. 3.6.4, and 3.7)

At scheduled hours, and/or on a per request basis, the Collector can poll the AMAT for billing and ancillary records (which include tracer records). At the Collector, the records are written onto magnetic tape and/or sent to the Revenue Accounting Office (RAO) for records processing. This is to ascertain that each billing record is in the proper format and contains valid data.

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An intermediate and time-saving scheme is to print the billing records from the magnetic tape via a high-speed line printer. This is done immediately after the billing records are written onto the tape, following a poll of the AMAT. Each billing record can be manually scrutinized and a decision can be made about the validity of the billing record format and data.

2.4.1 System Audit Counts (Needed for Section 3.6.4)

System audit counts, which appear as tracer records originating in the AMAT and processed and recorded by the Collector, can be analyzed and calculated from the tracer records in the billing records printout. This audit trail can determine if any billing records have been lost.

2.4.2 Tracer Records

There is a need to provide Quality Assurance (QA) and Quality Control (QC) functions so the BOCs can ensure that acceptable billing services are provided to the customer. This requires that QA/QC data be collected by the billing system (as tracer records) and transmitted through the billing data stream to the RAO. This tracer record data can measure billing services and should account for all billing data from point of entry at the switching system (request for AMA) to deposit of call information at the RAO. In addition to providing counts of losses known to the switching system, data for providing a complete audit should be included.

A brief description of the major and pertinent tracer records, relevant to auditing processes, is included in Table 1 in a general sequence of their occurrence on a Collector output tape. The details in each tracer record can be found in *LATA Switching Systems Generic Requirements (LSSGR)*, Section 8.1, Appendix E, "Sensor Specific Structure Codes[2]."

The chief analyzing tools of these tracer records are the 9042 "AMATPS Primary AMA Record Tracer," and the 9043 "AMATPS Secondary AMA Record Tracer," which are described in Section 2.4.3.

TABLE 1. Major and Pertinent Record Tracers

Structure Code	*Title*	*Major Function*
9036	Beginning of Recording	Tape sequence and transport number. This is the first record on the Collector tape.
9038	Logical Data Set - Header -	First block number of records received from the AMAT.
	- Followed by AMA Call Records -	
9042	AMATPS Primary AMA Record Tracer	Audit trail of AMA records initially polled by the Collector, from receipt by the AMAT to their being written to the Collector tape.
	- OR -	
9043	AMATPS Secondary AMA Record Tracer	Contains essentially the same audit trail as the 9042, but is generated when Collector repolls the AMAT for AMA records previously sent to the Collector.
9039	Logical Data Set - Trailer -	Last block number of records received from the AMAT, and a count of records and blocks in the LDS.
9037	End of Recording	Count of records, blocks, and the Collector logical data sets. This is the last record on the Collector tape.

2.4.3 AMATPS Primary and Secondary AMA Record Tracers

The Primary Record Tracer (9042) contains the count of records listed on page 5. The Secondary Record Tracer (9043) contains all Primary Record Tracer record counts but the count of the first field, "A. Count of records Teleprocessing Unit sent to disk."

- *Originating at the AMAT*
  - A. Count of records Teleprocessing Unit sent to disk
  - B. Count of records Teleprocessing Unit lost on disk
  - C. Count of records Teleprocessing Unit sent to data link
- *Inserted by the Collector*
  - D. Count of records the Collector received from data link
  - E. Count of records written to magnetic tape
  - F. Count of records lost in the Collector

The following balancing equations can be used to show if and where billing records have been lost.

$$A - B = C$$
$$C = D$$
$$D - F = E$$

2.4.4 Summary Statistics (Needed for Section 3.7)

Summary statistic reports, which generally include daily activities and billing records, obtain an overview of the entire AMAT/Collector system performance.

2.4.4.1 Daily Activity Report. A daily activity report reflects all Collector activity for a given day. The report is prepared on a per-port/per-AMAT basis and gives the number of:

- Polls
- Poll failures
- Blocks of data received
- Billing records received
- Unrecoverable communication failures
- Recoverable communication errors
- Amount of time each AMAT was being polled and port was used.

2.4.4.2 Billing Records Report. A billing records report is automatically obtained once a day from each AMAT. This report is also available from the AMAT by manual input command requests at the Collector. Report information includes counts of:

- Call originations
- Answered calls
- Unanswered calls
- Mutilated records

- Count of records the Teleprocessing Unit sent to disk
- Call records on AMAT disk sent to data link
- Long duration calls in progress
- Call records lost.

In addition, the report contains data link control information. This report is printed at the Collector line printer on an AMAT sending-unit basis.

2.5 RAO Match and Compare (M&C) Process (Needed for Sections 3.5 to 3.7)

The role of the RAO in the Match and Compare (M&C) process can be very valuable. Its supplementary services can be extended beyond providing the M&C program and process. The RAO is instrumental in aiding analyses of mismatches by:

- Searching for and printing call records for specific calling and called numbers
- Printing call records within specific timeframes from either, or both, billing sources
- Printing entire (or parts of) verbatims of either, or both, sources
- Printing call records by call type
- Including other billing data parameters, such as message unit calls, toll calls, Wide Area Telecommunications Service (WATS) calls, single-time line calls, long duration calls, short supervisory transition calls, etc.

2.6 The M&C Process (Needed for Sections 3.5, 3.6, and 3.6.2)

The ability of the Collector to correctly collect and record billing data from an AMAT can be analyzed using an operational AMAT. It also can be analyzed by using a new AMAT that will replace an existing billing system or an AMAT that is being installed in an office without a billing system. The M&C process only can be done if there are two billing data sources available. Therefore, it is assumed that one source will be provided by the switch (via options described below) and the other source will be the Collector magnetic tape.

The M&C process includes matching a set of calls from the new AMAT (provided by the Collector magnetic tape) against calls from any of the following options (if available):

1. Tape from the magnetic tape billing system not yet replaced by the new billing system.
2. If the switch does not have a magnetic tape billing system, from a test-call generating facility that creates a tape of its call records and whose calls have been collected by the new AMAT.
3. From a prerecorded list of calls generated by a precision load box programmed for customized call features.

For options 1 and 2, the tape records can be processed, matched, and compared by an appropriate M&C program at the RAO, or by a facility at another entity that is capable of performing the M&C process.

For option 3, the calls can be matched and compared by manually applying the precision load box list of generated calls against the AMAT tape calls printed at the Collector. This is described in Section 2.4.

The M&C process can sort, match, and compare each AMAT call record against the corresponding call record provided by options 1, 2, or 3. The sequence of sorting and matching the parameters of each pair of corresponding call records should be in the following call-event order. The accuracy criteria is given for each call event.

Call Event	Criterion
- Call Type	No Error
- Called Number	No Error
- Calling Number	No Error
- Seizure Time	±5 Seconds
- Seize Date	No Error
- Answer Time	±5 Seconds
- Answer Date	No Error
- Call Duration	+0, -2 Second
- MCD (Minimum Chargeable Duration)	± 0.1 Second

To ensure the validity of each M&C run, the following should be done:

1. Print a list of the first 100 *matched* call records.
2. Print a list of the *mismatched* call records (if any) from both sources.
3. Print a list of calls (if any) found on the AMAT tape, but not the calls on the existing billing system tape.
4. Print a list of calls found on the existing billing system tape, but not the calls on the AMAT tape.

Every discrepancy in mismatched and/or missing calls from both sources should be analyzed and satisfactorily explained and/or resolved.

2.6.1 Billing Accuracy (Needed for Sections 3.7, 3.7.1, and 3.7.2.2)

The purpose of the M&C process is to ascertain that Collector/AMAT discrepancies (not caused by design deficiencies) meet certain Billing Accuracy Acceptance Criteria values.

Table 2 shows the total Billing Accuracy Acceptance Criteria for an *entire* AMA Collection System (of which the Collector is a part). Table 3 allocates these total system errors to various components of the entire AMA Collection System. The allocations in the *Other Errors* section of Table 3 (10.92, 3.90, 27.00, 3.00) should be used to determine whether the Collector/AMAT system meets the Billing Accuracy Acceptance Criteria.

TABLE 2. Billing Accuracy Acceptance Criteria

a) Maximum 16 in 100,000 calls underbilled.

b) Maximum 11 in 100,000 calls unbilled.

c) Maximum 27 in 1,000,000 calls overbilled.

d) Maximum 3 in 1,000,000 calls charged to the wrong customer.

The above calls are defined as follows:

a) *Underbilled call* - Call that is incorrectly charged into a lower charge classification, not charged for the full duration, minimum billed, or charge guarded.

b) *Unbilled call* - Billable call that was not billed.

c) *Overbilled* - Charges to the customer more than the appropriate charges. This could be caused by errors in duration or charge classification.

d) *Charging the wrong customer* - Any charge to a billing number for a call that should not be charged to that number.

Also, a single equipment failure should not cause a loss of more than 10,000 call records.

TABLE 3. Billing Accuracy Acceptance Criteria for Collector and AMAT

System Allocation of Billing Error Standards

	UNDER-BILLED ($\times 10^{-5}$)	UN-BILLED ($\times 10^{-5}$)	OVER-BILLED ($\times 10^{-6}$)	WRONG CUSTOMER ($\times 10^{-6}$)
OUTAGE RELATED ERRORS				
Central Office	0.54	0.02	0	0
AMAT	2.54	5.08	0	0
AMAT to Collector	1.00	1.00	0	0
Collector	0.60	0.60	0	0
Collector to Mainframe	0.40	0.40	0	0
SUBTOTAL	5.08	7.10	0	0
OTHER ERRORS				
Central Office	3.64	1.30	9.00	1.00
AMAT	3.64	1.30	9.00	1.00
AMAT to Collector	$<10^{-9}$	$<10^{-9}$	$<10^{-9}$	$<10^{-9}$
Collector	2.18	0.78	5.40	0.60
Collector to Mainframe	1.46	0.52	3.60	0.40
SUBTOTAL	10.92	3.90	27.00	3.00
TOTAL	16.00	11.00	27.00	3.00

2.7 Acceptance Confidence Levels Based on Sample Size M&C Calls (Needed for Sections 3.7, 3.7.2, and 3.7.2.2)

Tables 4 to 7 can be used to determine the number of M&C calls necessary to make a Collector/AMAT acceptance or rejection decision with a reasonable level of confidence. These tables are based on the Billing Accuracy Acceptance Criteria of Table 3.

2.7.1 Description of Tables 4 to 7

Tables 4 to 7 provide the means for interpreting call volume test results. These tests are done to determine whether the Collector/AMAT system meets end-to-end billing accuracy standards for the Other Errors section of Table 3. Unexplained hardware failures cause rejection of the system.

The tables treat the observed number of incorrectly billed calls and the desired accuracy standard as input. They provide as output the call volume sample size required to justify acceptance or rejection at each of four confidence levels:

- 80 percent
- 90 percent
- 95 percent
- 99 percent.

2.7.2 Using Tables 4 to 7

The three examples below illustrate using Tables 4 to 7. In each example, assume that the desired Collector/AMAT accuracy level is 10.92 in 100,000 calls incorrectly billed. This is the Billing Accuracy Acceptance Criteria for the Other Errors underbilling shown in Table 3.

Example 1. A run of 25,000 calls results in no underbilled calls. In Table 4 we find c = 0. Because N = 25,000 is larger than the acceptance threshold for 90 percent confidence, we may conclude with 90 percent confidence that the system does meet the underbilling standard.

Example 2. A run of 75,000 calls results in 15 underbilled calls. In Table 4 we find c = 15. Since N = 75,000 is less than the 95 percent rejection threshold, we may, with 95 percent confidence, reject the system as not meeting the underbilling standard.

Example 3. A run of 30,000 calls results in two underbilled calls. The c = 2 line of Table 4 shows that neither acceptance nor rejection is justified at any of these confidence levels. Therefore, further volume testing is indicated.

These examples illustrate three possible outcomes, if "c" lies within the range of the tables. The tables do not decide to continue or end call-volume testing, but give conclusions after call-volume testing. The recommended use of the tables follows:

1. Decide the confidence required for acceptance and rejection.
2. Decide the maximum number of calls to be tested before a decision to accept or reject is made.
3. Decide what policy to follow when the maximum number of calls is reached and the results are not conclusive at the required levels. These policy choices are to:
   - Reject if the system is not acceptable after the maximum number of calls
   - Accept if the system is not rejectable after the maximum number of calls.

Tables 4 to 7 are sufficient to use with the four end-to-end, Other Errors, Billing Accuracy Acceptance Criteria in Table 3.

TABLE 4. Interpreting Call-Volume Test Results
Underbilled—10.92 Calls in 100,000

	Reject with X% confidence if N ≤ r(X)				Accept with Y% confidence if N ≥ a(Y)			
c	r(80)	r(90)	r(95)	r(99)	a(80)	a(90)	a(95)	a(99)
0	0	0	0	0	14738	21086	27433	42172
1	2043	965	470	92	27420	35620	43442	60791
2	7549	4870	3254	1360	39185	48739	57654	76978
3	14058	10093	7488	3993	50505	61180	71005	91987
4	21033	15978	12512	7539	61548	73202	83823	106273
5	28292	22277	18042	11713	72399	84933	96273	120046
6	35748	28864	23929	16349	83108	96447	108443	133434
7	43349	35667	30085	21339	93709	107793	120403	146520
8	51063	42638	36454	26613	104212	119002	132189	159368
9	58869	49748	42996	32120	114643	130092	143819	172005
10	66751	56972	49683	37822	125009	141090	155330	184478
11	74698	64293	56493	43693	135321	151996	166740	196795
12	82701	71698	63408	49709	145577	162839	178049	208984
13	90759	79176	70418	55853	155797	173608	189277	221053
14	98846	86718	77509	62110	165980	184322	200430	233022
15	106978	94322	84674	68469	176126	194982	211511	244899
16	115147	101969	91905	74919	186245	205604	222537	256685
17	123342	109670	99194	81452	196328	216172	233507	268407
18	131575	117418	106538	88062	206392	226703	244432	280046
19	139826	125192	113938	94744	216429	237207	255302	291621
20	148104	133013	121383	101484	226447	247665	266136	303141

Interpretation of test results for s = 1.092E-04

N = number of calls checked
c = number of erroneously billed calls

TABLE 4. Interpreting Call-Volume Test Results
Underbilled—10.92 Calls in 100,000 (Contd)

	Reject with X% confidence if N ≤ r(X)				Accept with Y% confidence if N ≥ a(Y)			
c	r(80)	r(90)	r(95)	r(99)	a(80)	a(90)	a(95)	a(99)
21	156401	140870	128864	108288	236438	258100	276923	314606
22	164716	148755	136392	115147	246419	268498	287683	326016
23	173059	156667	143956	122060	256374	278874	298397	337372
24	181410	164606	151548	129020	266319	289231	309084	348690
25	189789	172564	159176	136016	276245	299551	319744	359963
26	198178	180559	166841	143068	286154	309853	330375	371190
27	206575	188571	174524	150156	296053	320137	340971	382390
28	215000	196603	182244	157280	305934	330403	351548	393544
29	223425	204652	189982	164441	315806	340650	362097	404670
30	231868	212720	197747	171630	325668	350870	372628	415760
31	240330	220815	205540	178864	335513	361081	383132	426813
32	248791	228919	213342	186117	345348	371273	393608	437848
33	257271	237042	221181	193407	355174	381447	404075	448846
34	265760	245183	229029	200723	364991	391612	414524	459826
35	274258	253333	236905	208068	374799	401758	424945	470769
36	282766	261502	244789	215440	384597	411886	435357	481694
37	291282	269689	252701	222830	394386	422005	445751	492592
38	299808	277885	260623	230247	404167	432115	456117	503471
39	308342	286090	268562	237683	413947	442207	466484	514332
40	316877	294313	276520	245147	423709	452289	476832	525165

Interpretation of test results for s = 1.092E-04

N = number of calls checked
c = number of erroneously billed calls

TABLE 5. Interpreting Call-Volume Test Results
Unbilled—3.90 Calls in 100,000

	Reject with X% confidence if N ≤ r(X)				Accept with Y% confidence if N ≥ a(Y)			
c	r(80)	r(90)	r(95)	r(99)	a(80)	a(90)	a(95)	a(99)
0	0	0	0	0	41267	59041	76813	118082
1	5722	2702	1315	258	76777	99736	121638	170215
2	21138	13636	9112	3809	109718	136469	161431	215538
3	39362	28259	20966	11181	141413	171303	198813	257564
4	58892	44739	35033	21109	172333	204964	234705	297564
5	79218	62374	50518	32797	202718	237813	269564	336128
6	100095	80818	67000	45777	232703	270051	303641	373615
7	121377	99867	84239	59749	262385	301821	337128	410256
8	142977	119387	102072	74515	291795	333205	370128	446231
9	164833	139295	120390	89936	321000	364256	402692	481615
10	186903	159521	139113	105903	350026	395051	434923	516538
11	209154	180021	158179	122341	378897	425590	466872	551026
12	231562	200754	177544	139185	407615	455949	498536	585154
13	254126	221692	197169	156387	436231	486103	529974	618949
14	276769	242810	217026	173908	464744	516103	561205	652462
15	299536	264103	237087	191713	493154	545949	592231	685718
16	322410	285513	257333	209772	521487	575692	623103	718718
17	345359	307077	277744	228067	549718	605282	653821	751538
18	368410	328769	298308	246574	577897	634769	684410	784128
19	391513	350538	319026	265282	606000	664179	714846	816538
20	414692	372436	339872	284154	634051	693462	745179	848795

Interpretation of test results for s = 3.9E-05

N = number of calls checked
c = number of erroneously billed calls

TABLE 6. Interpreting Call-Volume Test Results
Overbilled—27 Calls in 1,000,000

	Reject with X% confidence if N ≤ r(X)				Accept with Y% confidence if N ≥ a(Y)			
c	r(80)	r(90)	r(95)	r(99)	a(80)	a(90)	a(95)	a(99)
0	0	0	0	0	59607	85282	110952	170563
1	8264	3902	1900	372	110900	144063	175700	245867
2	30533	19697	13162	5502	158481	197122	233178	311333
3	56856	40819	30285	16150	204263	247437	287174	372037
4	85067	64622	50604	30491	248926	296059	339019	429815
5	114426	90096	72970	47374	292815	343507	389370	485519
6	144581	116737	96778	66122	336126	390074	438593	539667
7	175322	144252	121678	86304	379000	435963	486963	592593
8	206522	172448	147437	107633	421481	481296	534630	644556
9	238093	201204	173896	129907	463667	526148	581667	695667
10	269970	230419	200941	152970	505593	570630	628222	746111
11	302111	260030	228481	176715	547296	614741	674370	795926
12	334478	289978	256452	201044	588778	658593	720111	845222
13	367070	320222	284800	225893	630111	702148	765519	894037
14	399778	350726	313481	251200	671296	745481	810630	942444
15	432667	381481	342459	276919	712333	788593	855444	990481

Interpretation of test results for s = 2.7E-05

N = number of calls checked
c = number of erroneously billed calls

TABLE 7. Interpreting Call-Volume Test Results

Billed to Wrong Customer—3.00 Calls in 1,000,000

	Reject with X% confidence if N ≤ r(X)				Accept with Y% confidence if N ≥ a(Y)			
c	r(80)	r(90)	r(95)	r(99)	a(80)	a(90)	a(95)	a(99)
0	0	0	0	0	536467	767533	998567	1.53507e+06
1	74380	35120	17098	3350	998100	1.29657e 06	1.5813e+06	2.2128e+06
2	274797	177270	118453	49520	1.42633e+06	1.7741e+06	2.0986e+06	2.802e+06
3	511700	367367	272563	145350	1.83837e+06	2.22693e+06	2.58457e+06	3.34833e+06
4	765600	581600	455433	274417	2.24033e+06	2.66453e+06	3.05117e+06	3.86833e+06
5	1.02983e+06	810867	656733	426367	2.63533e+06	3.09157e+06	3.50433e+06	4.36967e+06

Interpretation of test results for s = 3.0E-06

N = number of calls checked
c = number of erroneously billed calls

3. Analysis Procedures

The analysis procedures in this section include the major features in their likely order of execution.

3.1 Electrical Shock Hazards and Grounding

There should not be any exposed or open areas around electrical power junctions. Check for proper grounding of frames and/or cabinets. Using a voltmeter, measure the Collector cabinets for any voltage potentials.

3.2 Proper Ventilation

Inspect the area surrounding the Collector to determine that there is no blockage of the Collector ventilating system.

3.3 Maintenance Accessibility

There should be enough area around the Collector to allow for easy placement of instruments, such as scopes. The Collector must be designed for easy internal access and removal of all field-replaceable components.

3.4 Heat Sensors

If heat sensors are specified for the product, tests should be performed to show that the sensors activate when they reach their prescribed temperature threshold. This can be done by using a small commercial hair dryer directed on the heat sensors.

3.5 Preliminary M&C Analysis (Refer to Sections 2.2 to 2.6)

To determine that the Collector is operating per design objectives, one or more preliminary M&C runs should be done as described in Section 2.6. If a large number of mismatched calls appear in the analyses, major problems exist.

One of three methods can be used to do M&C runs:

1. If a new AMAT is to replace an existing billing system, the M&C runs require that the AMAT be connected for parallel operation with the magnetic tape drive of the billing system. In this configuration, both billing systems simultaneously collect and record the same billing data.
2. If a new AMAT is installed in an office without a billing system, a test-call generating facility (if available) that creates its own tape of call records should be matched against the AMAT call records.
3. If a new AMAT is installed in an office without a billing system, a precision load box (if available) should be used to generate known and recorded calls. These calls can be manually matched against the same test calls appearing on the AMAT/Collector tape.

At this point, it can be determined that the Collector correctly records all call types generated by that particular office.

3.6 Functional Operations Analysis (Refer to Sections 2.2 to 2.6)

3.6.1 System Operations

This is perhaps the most important analysis phase. Because the operation and maintenance of the Collector will be the on-going responsibility of Collector personnel, they should be thoroughly trained in operating the AMAT system. Also, it is recommended that Collector personnel conduct this analysis phase because they will be working with the Collector in the future.

Each functional operating specification of the Collector should be thoroughly tested several times to verify that all features can be easily operated and maintained.

The supplier should provide all operating specifications and instructions, input and output commands, work modules, and maintenance guides to analyze and remedy trouble conditions.

3.6.2 Fault Insertions (Refer to Section 2.6)

The type of inserted fault and the exact time it was inserted should be recorded while conducting fault insertion procedures.

Manual fault insertion procedures verify that the Collector can properly detect, identify, and interpret trouble conditions. The Collector should respond to these procedures by correctly detecting, recovering, and reporting trouble conditions.

The M&C process should be done during these procedures. Using this process, fault insertions can show the extent of revenue loss (lost and aborted calls) caused by certain trouble conditions. All faults should be detectable to the circuit board level.

The supplier should specify the exact circuit or major component locations where hardware and software faults can be introduced. If this is not possible, they should provide directions for emulating certain trouble conditions.

All input and output commands and pertinent information, and the action and error messages as described in all relevant documents of the supplier should be verified.

Depending on the severity of the fault, fault insertions should result in any or all of the following:

1. The appropriate audible and/or visible alarm conditions in the Collector are activated.
2. Appropriate alarm messages are printed.
3. The Collector diagnostics isolate inserted faults to the board level.

Each fault should be introduced sequentially, with no more than one fault at a time. After each fault is introduced, the Collector should be restored to its normal operating configuration.

Faults should be introduced that cause a printout for *each* and *every* error and/or status message as listed in the appropriate document of the supplier.

3.6.3 Fault Insertion Procedures

The fault insertion procedures are grouped into four major system categories:

- Alarm System Response
- Specific Collector Components
- Password Security Tests
- Datalink Tests.

3.6.3.1 Alarm System Response. The following procedures determine if the Collector design is capable of interfacing to, and activating, existing alarm points and the associated remotely located alarms (if available):

1. Verify that all alarms are activated at the local and remote alarms and that appropriate alarm trouble messages are generated.
2. Insert faults to emulate all conditions that will cause alarms.

3.6.3.2 Specific Collector Components. Each fault should be introduced sequentially, with no more than one fault at a time. For example, in the Disk fault procedure on the next page (No. 4), restore the disk before proceeding to the next step. After each fault is introduced, the Collector should be restored to its normal operating configuration. The following lists the specific fault insertion procedures:

1. *IPL (Initial Program Load or Reboot)*
    a. Turn the Collector off.
    b. Turn the Collector on and determine if the system IPLs.
    c. Introduce errors to make the Collector IPL.
2. *Line printer (if provided)*
    a. Insert faults that will be detected and reported by the Collector, such as turning off the printer and faulting the form check.
    b. Check the out-of-paper condition. This condition may turn off the form check and cause a paper jam.
    c. I/O terminal messages should contain printer trouble conditions.
3. *Tape drives (if provided)*
    a. Power down the tape drive and try to write.
    b. Remove the tape reel and try to write.
    c. Install the tape reel without the File Protect Ring and try to write.
    d. Insert an error in the tape header label; a soft shutdown, an alarm, and an I/O terminal message should occur.
    e. Mount a tape that has an invalid expiration date. Determine if the Collector rejects the tape.

4. *Disk*

   a. Turn off the disk.

   b. Simulate 70 percent, 90 percent, and 100 percent full conditions.

   c. Introduce faults that cause *all* disk error messages to print.

5. *CPU*

   Failure conditions that emulate alarm conditions should be inserted. Examples of these failure conditions are:

   a. Software errors—change a few words in the program.

   b. Machine errors—Memory Party Fail, I/O error, etc.

   c. Interface errors.

   d. Disk errors.

   e. Check that the timer is operating accurately by comparing it to the times stamped on I/O terminal messages.

3.6.3.3 Password Security Tests. This section addresses password security features required on Collector dial-up data links. The security strategy should be sufficient to prevent unauthorized personnel from gaining access to the Collector and to alert RAO personnel that unauthorized access has been attempted.

If the Collector has a dial-up/dial-back communication feature, it can be tested for security with the following procedures:

1. *AMAT—Collector data link security*
   This test verifies the response of the Collector to an invalid call on the dial-up data link. The dial-back data link has a terminating line appearance and can be called by another line. The Collector should answer all calls on the terminating line, but it should drop the connection after about two minutes if the caller is not a AMAT (i.e., the Collector is not expecting a call on this port from the AMAT, or the proper polling password is not received by the Collector).

   The AMAT should answer all calls on its terminating line. If the proper handshake and password is received, it dials the Collector on a second line; however, if the original call was not from the Collector, the Collector winks the call off because it is not expecting a call from this AMAT. This wink-off causes the AMAT to drop the connection on the first line. The following steps should be performed for this test:

   a. Dial the Collector polling terminating number from a subscriber line number and hold the line off-hook.

   b. The Collector should drop the dial-up connection after two minutes.

   c. The Collector I/O terminal should print a message.

   d. Change the AMAT database to indicate a new password without changing the Collector password database. Poll the AMAT from the Collector.

e. The Collector should make two additional attempts to poll, put out an alarm, and print an "Unable to Poll" message.

f. Using the proper password, dial the AMAT terminating line from a Collector not under test. The Collector under test should receive a call from the AMAT, but should wink it off.

2. *MMOC—Collector data link security*

a. Using the proper polling on the Collector remote port, have the Minicomputer Maintenance Operations Center (MMOC) request a *dump* of AMA call records from the Collector maintenance port. There should not be any response.

b. Using the proper polling password, have the MMOC try to stop the Collector operation. The Collector should continue operating.

3.6.3.4 Data Link Tests. These tests verify the printout of appropriate error messages, alarms, and/or the correct operational system responses to data link faults. They should be made for dial-up and dedicated lines and at the applicable data link transmission rates. It is assumed that the BX.25 protocol has been validated with the Bellcore test bed and verified by the Bellcore Billing Systems Technology Laboratory AMAT.

1. *Polling failure*
This test verifies that the Collector will make two more attempts to poll the AMAT when no polling response is received on the initial attempt. The Collector should bring in an alarm and print an Unable to Poll message.

a. Disconnect the AMAT data set (remove cord at data set end).

b. Initiate the poll.

c. An error message should be printed.

d. Verify the alarm.

2. *Data link lost during polling*
This test verifies the actions of the Collector and the AMAT when the dial-up data link is lost during polling. The following steps should be performed for this test:

a. Start the polling process. Remove the data set cable at the AMAT. An error message should be printed at the Collector.

b. Replace the data set cable and reinitiate the poll. The poll should be completed with no loss or duplication of billing data.

3. *Manual poll of AMAT data*
This test verifies that the AMAT can respond to repoll commands from the Collector and that all repolled data are marked Secondary Copy in the AMAT I.D. field. The following steps should be performed for this test:

a. Poll the current day's data.

b. Write the data on the Collector tape and remove the tape.

c. Wait one day.

d. Repoll the same data using a manual input command at the Collector.

e. Write the data on a second Collector tape and remove the tape.

f. Using the M&C process, the AMA data on both Collector generated tapes should match in detail, except that repolled data is marked Secondary Copy in the AMAT I.D. field of each call.

4. *Missing block sequence numbers*

   a. Emulate the missing block sequence numbers (and ascertain that the Collector logs them) by changing the AMAT software sequence numbers.

5. *Recovery of lost records*

   a. Inhibit some records from being received by the Collector. This can be done by moving the polled indicating pointers in the AMAT disk past some records so they will not be part of a poll.

   b. After removing the inhibit, repoll after moving the pointers back and ascertain that the inhibited records are received by the Collector.

6. *Non-AMA data exchange*
   Verify that time synchronizations, statistical dumps, program dumps, and operational control information can be exchanged between the Collector and the AMAT.

3.6.4 System Audit Counts (Refer to Sections 2.4 and 2.4.1)

If billing record audit counts are included in the supplier specifications, verify that these are maintained and balanced (as explained in Section 2.4.1).

3.7 System Acceptance Criteria (Refer to Sections 2.4, 2.4.4, 2.5, 2.6.1, and 2.7)

3.7.1 Final M&C Run (Refer to Section 2.6.1)

When the Collector is conditionally accepted as operational, is error-free, and hardware and software changes are no longer required, a final M&C run and analysis should be made.

This analysis verifies the accuracy of specific call events. A list of each event to be checked and its criterion for acceptance is included on page 7. Event time should be accurate to at least the accuracy specification of each system allocation component.

The comparison should result in zero calls mismatched because of *design* problems.

Synchronize all clocks before the M&C run starts and record the time differences.

3.7.2 Design Acceptance Criteria (Refer to Section 2.7)

3.7.2.1 Sample Size of M&C Calls. The sample size of M&C calls should be sufficient so error rates can be computed for at least 90 percent confidence levels.

At least 100,000 calls should be used to check for compliance with Billing Accuracy Criteria. These calls are spread over five contiguous days of system operation, with one of the days being the busiest of the week.

3.7.2.2 Billing Accuracy Criteria (Refer to Sections 2.6.1 and 2.7) The Billing Accuracy Acceptance Criteria for the total of both Outage Related Errors and Other Errors are detailed in the system error allocations of Table 3. Only allocation values for the Other Errors part should be used to reach the acceptance criteria (10.92, 3.90, 27.00, and 3.00).

Appendix A

Cross Reference of Sections for Tools and Facilities vs. Analysis Procedures

Tools and Facilities Sections	Analysis Procedures Sections
2.2 *AMAT at Bellcore*	3.5 Preliminary M&C Process 3.6 Functional Operations Analysis
2.3 *Collector at Bellcore*	3.5 Preliminary M&C Process 3.6 Functional Operations Analysis
2.4 *Audit Counts and Summary Statistics*	3.5 Preliminary M&C Process 3.6 Functional Operations Analysis 3.6.4 System Audit Counts 3.7 System Acceptance Criteria
2.4.3 *System Audit Counts*	3.6.4 System Audit Counts
2.4.5 *Summary Statistics*	3.7 System Acceptance Criteria
2.5 *RAO Match and Compare (M&C) Process*	3.5 Preliminary M&C Process 3.6 Functional Operations Analysis 3.7 System Acceptance Criteria
2.6 *The M&C Process*	3.5 Preliminary M&C Process 3.6 Functional Operations Analysis 3.6.2 Fault Insertions
2.6.5 *Billing Accuracy*	3.7 System Acceptance Criteria 3.7.1 Final M&C Run 3.7.2.2 Billing Accuracy Criteria
2.7 *Acceptance Confidence Levels*	3.7 System Acceptance Criteria 3.7.2 Design Acceptance Criteria 3.7.2.2 Billing Accuracy Criteria

Appendix B

Cross Reference of Sections for Analysis Procedures vs. Tools and Facilities

Analysis Procedures Sections	Tools and Facilities Sections
3.5 *Preliminary M&C Process*	2.2 AMAT at Bellcore 2.3 Collector at Bellcore 2.4 Audit Counts and Summary Statistics 2.5 RAO Match and Compare (M&C) Process 2.6 The M&C Process
3.6 *Functional Operations Analysis*	2.2 AMAT at Bellcore 2.3 Collector at Bellcore 2.4 Audit Counts and Summary Statistics 2.5 RAO Match and Compare (M&C) Process 2.6 The M&C Process
3.6.2 *Fault Insertion*	2.6 The M&C Process
3.6.4 *System Audit Counts*	2.4 Audit Counts and Summary Statistics 2.4.1 System Audit Counts
3.7 *System Acceptance Criteria*	2.4 Audit Counts and Summary Statistics 2.5 RAO Match and Compare (M&C) Process 2.4.4 Summary Statistics 2.6.1 Billing Accuracy 2.7 Acceptance Confidence Levels
3.7.1 *Final M&C Run*	2.6.1 Billing Accuracy
3.7.2 *Design Acceptance Criteria*	2.7 Acceptance Confidence Levels
3.7.2.2 *Billing Accuracy Criteria*	2.6.1 Billing Accuracy 2.7 Acceptance Confidence Levels

REFERENCES

1. *AMATPS Collector Generic Requirements*, Bell Communications Research, TA-TSY-000237, Issue 2, November 1985.

2. *LATA Switching Systems Generic Requirements (LSSGR)*, Bell Communications Research, TR-TSY-000064, Issue 1, December 1984; Revision 2, June 1985.