Bell Communications Research

Bellcore Practice
BR 201-510-002
Issue 1, December 1985

High-Level Generic Analysis Plan For Automatic Message Accounting Transmitters (AMATs)

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

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CONTENTS

1. Introduction

This document provides a high-level, comprehensive analysis plan for determining whether an Automatic Message Accounting Transmitter (AMAT) meets all pertinent Bellcore generic requirements. It assumes that the source of requirements is Bellcore's *AMA Transmitter 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 an AMAT 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 AMAT Analysis*, and Section 3—*Analysis Procedures*. Section 2 lists and describes the tools and facilities recommended to perform the analysis procedures of Section 3.

1.1 Analysis Ground Rules

The Analysis Plan in this document is tailored for an AMAT that replaces an existing billing output device (such as dual tape recorders) of a switching office, or for an AMAT that is installed in an office without its own billing output device. For the latter case, some parts of the Plan cannot be performed; however, the applicable parts can be extracted and used accordingly.

2. Tools and Facilities for AMAT Analysis

This section lists and describes the tools and/or facilities recommended to perform the AMAT 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 Load Boxes (Needed for Sections 3.6 to 3.9)

Two types of load boxes can be used to enhance the AMAT analysis process.

2.1.1 Volume Load Box

The volume load box can be one of several general-purpose types that generate large numbers of identical calls on each connected test line number. Typically, this type of load box has a few basic calls (with minor differences in call parameters) repeated cyclically. To create a sufficient volume of calls for analysis, the volume load box can be implemented as a call-volume supplement. This will create additional calls in offices that normally do not have a sufficient daily volume of live, billable customer calls.

2.1.2 Precision Load Box

A precision load box can provide a variety of precision calls in which each call parameter can be programmed within a range of user-prescribed values. Consequently, each test line number connected to this load box can have customized call features resulting in wide call variations.

2.2 Collector at Revenue Accounting Office (RAO) (Needed for Sections 3.6, 3.7, 3.8, 3.8.3, and 3.9)

The Collector, which is generally located at the RAO, is used frequently during an AMAT analysis. At scheduled hours, and/or on a per request basis, the Collector can poll the AMAT for billing and ancillary records. At the Collector, the records are written onto magnetic tape and/or sent to the RAO for records processing. This is to ascertain that each billing record is in the proper format and contains valid data.

An intermediate and time-saving feature of the Collector 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 the Collector's 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.

2.3 Collector at Bellcore (Needed for Sections 3.6 to 3.8)

If an active Collector is not available during the AMAT analysis procedures, the No. 1A Collector at the Bellcore Billing Systems Technology Laboratory can be used.

2.4 System Audit Counts and Summary Statistics

2.4.1 System Audit Counts (Needed for Sections 3.8.4 and 3.9)

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 included in the billing records printout (as described in Section 2.2). This audit trail can determine if any billing records have been lost.

2.4.2 Tracer Records

There is a need to provide both 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 contained 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 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 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 3.9)

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 3.6 to 3.9)

The role of the RAO in the 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 in the analysis 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 3.6, 3.7, 3.7.2.6, 3.8.2, and 3.9)

The M&C process includes matching a set of calls from the 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 (see Section 2.1.2).

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 2.2.

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 3.9, 3.9.1, and 3.9.2.2)

The purpose of the M&C process is to ascertain that AMAT/Collector 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 AMAT 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 AMAT/Collector 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 3.9, 3.9.2, and 3.9.2.2)

Tables 4 to 7 can be used to determine the number of M&C calls necessary to make an 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 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 AMAT accuracy level is 10.92 in 100,000 calls incorrectly billed. This is the Billing Accuracy Acceptance Criteria for 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	299538	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	4.3696e+

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. The procedures are based on the assumption that the AMAT includes two sending units (SUNs) configured in a duplex mode of active and standby states. If the AMAT is a simplex system with one SUN, only the appropriate procedures apply.

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 AMAT cabinets for any voltage potentials.

3.2 Proper Ventilation

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

3.3 Maintenance Accessibility

There should be enough area around the AMAT to allow for easy placement of instruments, such as scopes. The AMAT 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 Electrical Grounding

Grounding (earth, signal, frame) should be compatible with the central office (CO) grounding scheme (i.e., it should not interfere with CO signal grounding).

3.6 Preliminary M&C Analysis (Refer to Sections 2.1, 2.2, 2.3, 2.5, and 2.6)

To determine that the AMAT is operating per design objectives, one or more preliminary M&C runs for the active and standby SUNs should be made. 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 the 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 the 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 can be matched against the AMAT call records.
3. If the 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 AMAT correctly records all call types generated by the CO.

3.7 Environmental Analysis (Refer to Sections 2.1, 2.2, 2.3, 2.5, and 2.6)

There are two environmental product tests to determine if each system component can operate normally during potential environmental changes.

3.7.1 Vibration Tests

This test includes a series of vibration tests, such as earthquake shock tests. Since these tests cannot be conducted on-site, they are performed at an approved testing facility before shipment, and written test results should be required. The equipment should be certified to earthquake requirements as specified in LSSGR Sections 14.4 and 14.5[2].

3.7.2 On-Site High Temperature Tests

Not all thermal procedures and requirements specified in the LSSGR are possible for on-site temperature testing; therefore, some items in the procedures have been eliminated (e.g., humidity, low temperature), while other items have been modified as outlined in Sections 3.7.2.1 to 3.7.2.6.

An M&C run should be made while the temperature tests are being conducted and both AMAT SUNs should be on line.

3.7.2.1 Temperature Enclosure. To elevate temperature only around the AMAT, an enclosure of polyethylene sheets (or the equivalent) that will fit over both AMAT SUNs should be used. The enclosure should be large enough so personnel can enter and portable household heaters and fans can be stationed within it. The enclosure should *not* include the data communications peripherals, such as data sets, cables, etc.

The front and rear of the enclosure should have access to the inside so the temperature in the frame can be quickly and easily reduced should emergencies occur. Holes should be provided in various sheet locations so monitoring thermometers can be inserted.

3.7.2.2 Equipment. The equipment necessary to conduct high temperature tests are listed below. Some items may not be used if impracticable.

- An electronic thermometer (if available)
- Heavy wattage (> 1600 Watts) portable household heaters

- Household fans (for air movement in the enclosure)
- Thermometers
- Spare AMAT parts.

3.7.2.3 Safeguards. The following are the safeguards necessary while conducting high temperature tests:

1. The temperature run must be carefully executed so hardware components are not damaged during temperature variation runs. For example, if the maximum temperature specification of the system component (each of which may have various temperature limitations) is threatened and cannot be controlled, the test will be aborted. In addition, if serious malfunctions in the AMAT are apparent, the test will be aborted and an analysis and decision will be made about whether to continue temperature testing.
2. The standard maximum ambient *short-term* temperature in COs is 120°F for one hour; the maximum ambient *normal* operating temperature is 100°F for one hour.

3.7.2.4 Test Preparation. Before making the temperature run, the equipment can be installed and preliminary and precautionary measurements can be made. The following lists these test preparations:

1. The location where ambient temperatures are measured is 5 feet from the floor and 15 inches from the front of the AMAT. The thermometer should be placed there to serve as the benchmark point for measuring and monitoring the ambient temperature throughout the temperature run.
2. Place a second thermometer at the appropriate location in the rear of the AMAT enclosure.
3. Place one heater and one fan on the floor in the front of the heater, and place one heater and one fan in the rear of the enclosure. *Do not turn on the heaters.*
4. AMAT I/O terminals should be located outside the enclosure.
5. Turn on the heaters (at a low heat) and fans and let the temperature rise 10°F per hour. Try to control the stability of this temperature plateau by varying the heater control. This is a precaution to test the capability of controlling and stabilizing a temperature plateau without overshooting the plateau and also not having the temperature rise too rapidly. This is necessary to guard against overshooting at the highest temperature of the test or having the temperature rise too rapidly, which could damage or endanger the AMAT hardware.
6. Monitor each thermometer as the temperature rises to check that they are all operating properly.

3.7.2.5 Temperature Test Procedures. After all preparations are completed and control of the enclosure temperature is assured, the temperature test can begin. The following lists all temperature test procedures:

1. Throughout the temperature run, record the thermometer reading every 5 minutes and monitor for any rapid and excessive temperature increase.

2. Gradually elevate the temperature 10°F every hour until the maximum desired objective temperature is reached. Remain at each 10°F plateau until the temperature stabilizes.
3. Monitor the AMAT I/O terminals for any indication of AMAT operating degradations.
4. If malfunctions start to occur, record the malfunction, the time, and temperatures at the thermometer locations.
5. If it is decided to abort the temperature run, gradually decrease the ambient temperature 10°F per hour by: (1) reducing the heat generated by the heater(s), (2) opening the rear (or front) enclosure wall, and (3) opening the front (or rear) enclosure wall. Do not let the temperature decrease rapidly.
6. When the 100°F temperature is reached, verify that this can be constantly maintained and that overshooting does not occur. Allow a one hour stability period.
7. Perform the following while at 100°F:
    a. Run AMAT diagnostics on the active and standby SUNs.
    b. Have the Collector poll both AMAT SUNs, and then do a M&C to ascertain that calls have not been lost during the temperature runs.
    c. Switch over the active and standby AMAT SUNs.
    d. Wait 30 minutes.
    e. Have the Collector poll the now-active SUN (formerly the standby SUN in step b above) and the formerly active unit.
8. Increase the temperature to 110°F and let it stabilize for one hour.
9. Repeat the procedures in step 7.
10. Increase the temperature to 120°F and let it stabilize for one hour.
11. Repeat the procedures in step 7.
12. Decrease the temperature 10°F per hour until the room temperature is reached.

3.7.2.6 Temperature Test Acceptance Criteria (Refer to Section 2.6). An M&C analysis should be made for the length of the temperature run. If M&C mismatches occur because of system design deficiencies, and/or I/O terminal error messages indicate that the AMAT did not function normally during the temperature run, the malfunction(s) should be remedied and the temperature run and M&C analysis should be repeated until the AMAT operates normally during high temperature runs.

3.8 Functional Operations Analysis (Refer to Sections 2.1, 2.2, 2.3, and 2.5)

3.8.1 System Operations

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

Each functional operating specification of the AMAT 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.

3.8.2 Fault Insertions (Refer to Section 2.6)

The fault insertion procedures apply to both AMAT SUNs. 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 AMAT can properly detect, identify, and interpret trouble conditions. The AMAT should respond by correctly detecting, recovering, and reporting trouble conditions. Using the M&C process, fault insertions can reveal the extent of revenue loss (lost calls and aborted calls) caused by certain trouble conditions. All faults should be detectable to the circuit board level. Identical faults should be introduced in both AMAT SUNs. All clocks should be synchronized and the differences recorded.

An M&C should be done between the office tape and the AMAT/Collector tape (for the active and standby SUNs) during these fault insertion procedures.

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 AMAT, the office, and the Switching Control Center (SCC) are activated.
2. Appropriate alarm messages are printed.
3. The active SUN will switchover to the standby SUN.
4. The AMAT 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 AMAT system 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.

3.8.3 Fault Insertion Procedures

The fault insertion procedures are grouped into five major system categories and should be performed on both SUNs:

- Alarm System Response
- Specific AMAT System Components
- Password Security Tests
- Datalink Tests
- SCC and MMOC Communications.

3.8.3.1 Alarm System Response. The following procedures determine if the AMAT system design is capable of interfacing to, and activating, existing local office alarm points and the associated remotely located alarms:

1. Verify that all alarms are activated at the AMAT, SCC, and switch, and that appropriate alarm trouble messages are generated.
2. Insert faults to emulate all conditions that will cause alarms.
3. The switch should detect the failure of the active SUN and processing should be switched to the standby SUN. The switch should activate audible and visible alarms.

3.8.3.2 Specific AMAT System Components. Each fault should be introduced sequentially, with no more than one fault at a time. For example, in the Disk fault insertion procedure listed below (No. 3), restore the disk before proceeding to the next step. After each fault is introduced, the AMAT system should be restored to its normal operating configuration.

All trouble conditions should be received at the SCC as alarms and terminal messages.

The following lists the specific fault insertion procedures:

1. *Interface*
   a. Using grounding or other methods, insert a fault in the AMAT interface control and data leads.
   b. Run the AMAT diagnostic.
   c. Run the switch AMA diagnostics.
   d. Check all resulting error messages on the switch I/O terminal and on the SCC and AMAT I/O terminals.
2. *AMAT Power Down and Power Up Sequences*

   If a power failure occurs, this test verifies that the AMAT will switchover from the active SUN to the standby SUN with minimal data loss. Observe that switch actions, alarms, and terminal messages occur appropriately. The following steps should be performed to conduct this test:

   a. Power down the active SUN.
   b. Observe that the switch transfers AMA data collection from the unpowered SUN to the other SUN.
   c. Note that an error message has printed on the I/O terminal of the newly activated SUN.

d. Power up the formerly active SUN.

e. Observe that this SUN reinitializes and assumes the out-of-service state.

f. From the I/O terminal connected to the switch, enter the instructions that change this SUN from out-of-service to standby.

g. Repeat the test with the new active SUN.

The previous test verifies proper recovery from power failure at the active SUN. To test power failure at the standby SUN, perform these steps:

a. Power down the standby SUN.

b. Note that an error message has printed on the I/O terminal at the active SUN.

c. Power up the former standby SUN.

d. Observe that this SUN reinitializes and assumes the out-of-service state.

e. From the I/O terminal connected to the switch, enter the instructions that change this SUN from out-of-service to standby.

f. Repeat the test after switching the active SUN and standby SUN states.

g. Check that *all* power switchover error messages are printed where appropriate.

h. Power down the standby unit. Insert a fault in the active SUN that would normally cause the active unit to switchover to the standby unit. The active SUN should *not* switchover to the standby SUN, but should continue operating.

3. *Disk*

a. Introduce faults that cause *all* disk error alarms and messages to print.

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

4. *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 active unit program.

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

c. Interface errors.

d. Disk errors.

e. Insert *soft* faults in the active SUN with the standby SUN disabled; the active SUN should not shut down.

f. Insert hardware and software faults that cause the system to automatically IPL (Initial Program Load or reboot).

g. Insert faults in the CPU that cause *all* CPU error messages to be printed.

h. Check that the AMAT clock is operating accurately by comparing the times stamped on error messages with a known time-of-day source.

i. The asynchronous ports used are operating properly if the SCC and MMOC can initiate communications with the AMAT.

3.8.3.3 Password Security Tests. This section addresses password security features required on AMAT dial-up data links. The security strategy should be sufficient to prevent unauthorized personnel from gaining access to the AMAT and to alert craftspersons that unauthorized access has been attempted. The following procedures should be used:

1. *AMAT-Collector data link security*

   This test verifies the response of the AMAT to an invalid call on the dial-up data link. The dial-up data link has a terminating line appearance and can be called by another line. The AMAT will answer all calls on the dial-up data link, but it will drop the connection after about two minutes if the call is not from the Collector. When the AMAT receives the call, it dials the Collector on a second line; however, the Collector winks the call off because it is not expecting a call. This wink-off causes the AMAT to drop the connection on the first line. Total time for the complete operation is about two minutes. The following steps should be performed for this test:

   a. Dial the AMAT polling number and hold the line off-hook.

   b. The AMAT will answer the call and drop the dial-up connection after two minutes, causing the originating line to return to the dial tone.

   c. Change the AMAT database to indicate a new ID without changing the Collector database. Dial the AMAT and send the password from the Collector.

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

   e. Repeat steps a to d for the standby SUN.

2. *MMOC/SCC/AMAT data link security*

   a. Using the proper polling password, try to stop the operation of the AMAT active SUN from the SCC and the MMOC. The active SUN should continue to operate. The AMAT standby SUN, however, can be stopped.

   b. Repeat the above for the standby SUN.

3.8.3.4 Data Link Tests. These tests verify the generation of appropriate error messages and/or the correct system response to data link faults. They should be made for dial-up and dedicated lines at the applicable data link transmission rates.

It is assumed that the BX.25 protocol has been validated by the Bellcore test bed and verified by the Bellcore Billing Systems Technology Laboratory Collector.

1. *Data link lost during polling*

   This test verifies the actions of 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. Disconnect the data set cable at the AMAT. An error message should be printed at the AMAT I/O terminal.

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

   c. Repeat this process for the standby SUN.

2. *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 sensor I.D. field. During this test the state of the active and standby units should be reversed, so AMA data from both is on the Collector tape. The following steps should be performed for this test:

   a. Poll the current day's data.

   b. Wait one day.

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

   d. Data on both Collector-generated tapes should match in detail, except that repolled data is marked Secondary Copy in the sensor I.D. field of each call.

3. *Processor-to-processor communications*

   Mutual monitoring is implemented over the AMAT processor-to-processor communications link. A periodic monitoring task in each processor should receive an indication from the other processor that it (the other processor) is operative. If this indication ceases, a minor alarm is activated.

   Insert faults to cause all processor-to-processor error messages and alarms.

4. *Transmission errors during data transmission*

   The following procedures should be performed for this test:

   a. Insert a fault at the AMAT that causes a high incidence of transmission errors during a poll. This can be done by momentarily disconnecting the AMAT data set several times. The poll should abort and a new poll should be initiated over a different dial-up line.

   b. Repeat this process for the standby SUN.

3.8.3.5 SCC and MMOC Communications. This test verifies that the AMAT SUNs can be dialed up from a SCC location (and MMOC, if so equipped) and that AMAT communications are established. The following procedures should be performed for this test:

a. Dial the active SUN.

b. Sign on.

c. Determine that the AMAT site responds with the correct messages.

d. Sign off.

e. Repeat steps a to d for the standby SUN.

f. Check that all messages are received from both AMAT units.

g. Ascertain that all AMAT remote operations can be initiated and performed remotely from the SCC and/or the MMOC.

h. Turn both SUNs off. This should be interpreted by the SCC as a Both Units Down condition, indicating that billing data is not being collected by the AMAT.

3.8.4 System Audit Counts (Refer to Sections 2.2 and 2.4.1)

If billing record audit counts are included in the specifications of the supplier, verify that counts of billing records are maintained for the following:

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.

The counts should balance by using the equation: A - B = C.

3.9 System Acceptance Criteria (Refer to Sections 2.1, 2.2, 2.4.1, 2.4.4, 2.5, 2.6.1, and 2.7)

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

When the AMAT billing system 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 times should be accurate to at least the accuracy specification of each system 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.

3.9.2 Design Acceptance Criteria (Refer to Section 2.7)

3.9.2.1 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.

The following activities should be made to occur during the five test days:

1. The Collector fails to poll on one cycle.
2. At least one AMAT soft switchover.
3. The SCC accesses both AMAT units.
4. At least one office-initiated switchover per day.
5. The Collector initiates at least one daily repoll session to each AMAT SUN.

3.9.2.2 Billing Accuracy Acceptance Criteria (Refer to Sections 2.6.1 and 2.7). The Billing Accuracy Acceptance Criteria for the totals 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, 3.00).

Appendix A

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

Tools and Facilities Sections	Analysis Procedures Sections
2.1 *Load Boxes*	3.6 Preliminary M&C Analysis 3.7 Environmental Analysis 3.8 Functional Operations Analysis 3.9 System Acceptance Criteria
2.2 *Collector at RAO*	3.6 Preliminary M&C Analysis 3.7 Environmental Analysis 3.8 Functional Operations Analysis 3.8.4 System Audit Counts 3.9 System Acceptance Criteria
2.3 *Collector at Bellcore*	3.6 Preliminary M&C Analysis 3.7 Environmental Analysis 3.8 Functional Operations Analysis
2.4.1 *System Audit Counts*	3.8.4 System Audit Counts 3.9 System Acceptance Criteria
2.4.4 *Summary Statistics*	3.9 System Acceptance Criteria
2.5 *RAO Match and Compare (M&C)*	3.6 Preliminary M&C Analysis 3.7 Environmental Analysis 3.8 Functional Operations Analysis 3.9 System Acceptance Criteria
2.6 *The M&C Process*	3.6 Preliminary M&C Analysis 3.7 Environmental Analysis 3.7.2.6 Temperature Test Criteria 3.8.2 Fault Insertions 3.9 System Acceptance Criteria
2.6.1 *Billing Accuracy*	3.9 System Acceptance Criteria 3.9.1 Final M&C Run 3.9.2.2 Billing Accuracy Criteria
2.7 *Acceptance Confidence Levels*	3.9 System Acceptance Criteria 3.9.2 Design Acceptance Criteria 3.9.2.2 Billing Accuracy Criteria

Appendix B

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

Analysis Procedures Sections		Tools and Facilities Sections	
3.6	*Preliminary M&C Analysis*	2.1	Load Boxes
		2.2	Collector at RAO
		2.3	Collector at Bellcore
		2.5	RAO Match and Compare (M&C)
		2.6	The M&C Process
3.7	*Environmental Analysis*	2.1	Load Boxes
		2.2	Collector at RAO
		2.3	Collector at Bellcore
		2.5	RAO M&C
		2.6	The M&C Process
3.7.2.6	*Temperature Test Criteria*	2.6	The M&C Process
3.8	*Functional Operations Analysis*	2.1	Load Boxes
		2.2	Collector at RAO
		2.3	Collector at Bellcore
		2.5	RAO M&C
3.8.2	*Fault Insertions*	2.6	The M&C Process
3.8.4	*System Audit Counts*	2.2	Collector at RAO
		2.4.1	System Audit Counts
3.9	*System Acceptance Criteria*	2.1	Load Boxes
		2.2	Collector at RAO
		2.4.1	Collector at Bellcore
		2.4.4	Summary Statistics
		2.5	RAO M&C
		2.6	The M&C Process
		2.6.1	Billing Accuracy
		2.7	Acceptance Confidence Levels
3.9.1	*Final M&C Run*	2.6.1	Billing Accuracy
3.9.2	*Design Acceptance Criteria*	2.7	Acceptance Confidence Levels
3.9.2.2	*Billing Accuracy Criteria*	2.6.1	Billing Accuracy
		2.7	Acceptance Confidence Levels

REFERENCES

1. *AMA Transmitter Generic Requirements*, Bell Communications Research, TA-TSY-000223, 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.