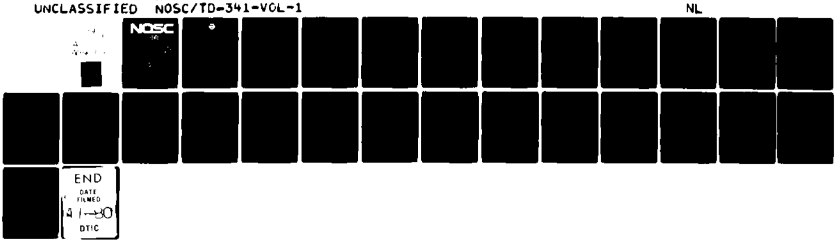
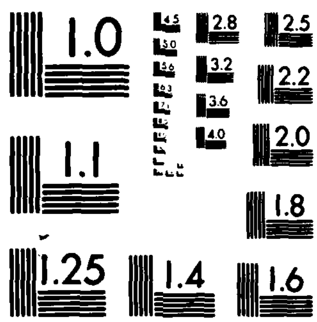
AD-A090 715 NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA F/G 17/2.1
QUALITY MONITORING SYSTEM (QMS) REQUIREMENTS. TERMINOLOGY, MEAS--ETC(U)
APR 80 J R CAMPBELL, J R BEAUCHANE, J LOPEX
UNCLASSIFIED NOSC/TD-341-VOL-1 NL



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Technical Document 341

# VOLUME 1
# QUALITY MONITORING SYSTEM (QMS) REQUIREMENTS

## Terminology, measurement parameters, and automation requirements

JR Campbell and JR Beauchane, NOSC
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AD A090715

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Final Report

9 April 1980

Prepared for
Naval Electronic Systems Command
Code 310

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## ADMINISTRATIVE INFORMATION

The work was performed by a team under the guidance of NOSC Code 8111 with John R. Campbell as the principal investigator; for project X0720-CC, tasked by NAVELEX Code 310 under the Advanced Communications Control System (ACCS) Program PE24163N. COMNAVSURFPAC and Systems Explorations, Inc., and Computer Sciences Corporation personnel providing additional assistance.

Released by
MS Kvigne, Head
Communications Research
and Technology Division

Under authority of
HD Smith, Head
Communications Systems
and Technology Department

## ACKNOWLEDGEMENTS

The following are specifically acknowledged for their contributions to this Technical Document. The work was accomplished at NOSC under the guidance and review of AB Cranmore and WD Carpenter of NOSC Code 8111 and D Sweet, NAVELEX Code 310. Important contributions were provided by AR Evans, NOSC Code 8141; V Ybarra, Computer Sciences Corporation, San Diego, CA; and LCDR Rhudy and RMCS Edson of COMNAVSURFPAC, San Diego, CA.

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# REPORT DOCUMENTATION PAGE

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| | | |
|---|---|---|
| 1. REPORT NUMBER<br>NOSC Technical Document 341 (TD341) | 2. GOVT ACCESSION NO.<br>AD-A090 715 | 3. RECIPIENT'S CATALOG NUMBER<br>9 |
| 4. ~~TITLE (and Subtitle) Vol. 1~~ 6<br>QUALITY MONITORING SYSTEM (QMS) REQUIREMENTS, Terminology, measurement parameters, and automation requirements. Volume I. | | 5. TYPE [redacted] OD COVERED<br>T&E Final Report.<br>Oct[redacted]79 [redacted] Apr[redacted] |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) 10<br>J. R. ~~JR~~ Campbell [redacted] J. R. Beauchane [redacted],<br>J. J. Lopez, ~~Systems Exploration, Inc.~~ | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Naval Ocean Systems Center,<br>San Diego, CA 92152 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>16 X0720CC PE 24, 24163N<br>17 X0720CC |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Naval Electronic Systems Command,<br>Code 310 | 12 26 | 12. REPORT DATE 11<br>9 Apr[redacted] |
| | | 13. NUMBER OF PAGES<br>22 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)<br>14 NOSC/TD-341-Vol-1 | | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited. (Vol. 1).
(Vol. 2. Distribution limited to U.S. Government agencies only.)

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Approved for public release, distribution unlimited. (Vol. 1).
(Vol. 2. Distribution limited to U.S. Government agencies only.)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Advanced Communications Control Systems (ACCS)
Circuit monitoring
Communication system monitoring
Equipment monitoring
Performance Quality
Quality Monitoring Systems

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Measurement parameter requirements are established, in priority ranking, for quality monitoring of Navy communications equipments and circuits. Recommendations are made relative to automatic or manual measurement of specified parameters, or to perform the measurements during normal maintenance.

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## SUMMARY

Shipboard quality monitoring (QM) of communications is an established requirement. Many programs and projects through the years have tried to address this requirement but unfortunately the present day QMS still relies on the interpretation of the user for communication quality monitoring. This user assessment of the communication usually generates the requirement to test and evaluate the equipment and circuit. Shipboard QMS should determine if the ship's communication circuits are performing satisfactorily, marginally or are in a fault condition. The QMS should also provide for the isolation of marginal and faulty shipboard equipment within the end-to-end circuit. To eliminate subjective QM, two areas had to be developed 1) technology and 2) the formulation of measurement criteria.

1) Within the past few years the use of communications equipments has expanded to such an extent that "user monitoring" alone is not fast enough, reliable enough, or consistent enough to provide effective communications. Also in the past few years technology in the microprocessors and test equipments has progressed to a point where automatic monitoring of the parameters required to determine equipment and circuit performance is possible.

2) Equipment status (satisfactory/fault) specifications have been established and documented. However, specifications to determine marginal performance have not been defined nor have the tolerances been established. Similarly, circuit satisfactory communications standards have been established and documented. However, existing circuit standards do not address an intermediate level such as marginal performance.

NOSC, under the sponsorship of Elex 310, developed a list of parameters (section 4.0), that if measured will provide a basis to determine if end-to-end circuit and equipment status is *satisfactory, marginal* or in a *fault* condition.

This document focuses on the parameters that determine system end-to-end circuit quality and equipment performance. To maintain effective communication does not require that all the parameters listed be automatically monitored and tested. Therefore, a prioritized parameter list was developed (section 5) that identifies the QMS requirements for manual or automatic measurement.

This document does not address the QMS to communication equipment interconnection and the speed of measurement requirements for QMS. It also should be noted that to effectively accomplish the parameter monitoring and testing, it is required to have signal access ports available for monitoring and testing individual equipments within the equipment string. Switches are a most desirable access point. Effective and timely measurements, and evaluation of the parameters is required to provide circuit quality monitoring. A QMS can be used as a stand alone system, but to effectively use this capability, centralized control, automatic switching and resource and traffic controllers are required.



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## CONTENTS
## VOLUME I

## FIGURES



## TABLES

# 1. SCOPE

## 1.1 PURPOSE

This document establishes the parameters for shipboard quality monitoring systems (QMS) for present and future communications equipments to help assure reliable communication system performance. In support of these requirements are definitions of circuit and equipment performance. QMS automation levels are defined and parameter measurement automation levels recommended.

## 1.2 APPLICATION

This is a requirements document therefore does not include costing and technical implementation criteria. If technology and cost prohibits implementation of a parameter or a set of parameters, it does not eliminate the requirement, but should be implemented at a later date. This document and parameters listed should be used as a guideline for present and future communication QMS requirements. In today's communication environment not all of the parameters have to be measured automatically, but as the demand for communication increases so will the requirements to automated parameters. The parameters are listed to complement modular and cost-effective approaches to shipboard communication QMS development. Again, these parameters are independent of the type of implementation, and they are of value if measured manually or to any degree of automation.

## 1.3 INFORMATION SOURCES

The information for this document was obtained from various sources. Part is from the bibliography of Volume 2 of this Technical Document and part is from the recent experiences of several ships' technical control facility operators. The following quality monitoring systems are currently deployed and were examined:

1. C2796.1 (NAVTELCOMINST)
2. DD963/CG-47
3. LHA-1
4. CVN-68 (SRM-17)
5. SSQ-65(A)/SSQ-65(B)

In addition, the QMS development under the QMEG(AN/SSQ-88) program was examined. The above system's capabilities provided an insight of the partial QMS requirements. Each one is a subsystem of the Technical Control Facility (TCF) and the analysis focused on the QMS functioning as a central monitoring point utilizing TCF assets of test equipment and patching facilities to perform quality monitoring. Analysis to determine the capabilities of the SSQ-88 was limited to only the information provided by the installation drawings used to install the SSQ-88 QMS aboard the USS AMERICA. The analysis of the six systems listed above verified that the present QMS operations are performed manually and they do not have the capabilities to measure all the required parameters essential for an afloat QM system.

# 2. QMS TERMINOLOGY

## 2.1 QUALITY MONITORING SYSTEM (QMS)

A QMS provides information to the technical control facility as to the operating status or operational readiness of the ship's exterior communications system. It also provides information as to the nature and location of failures and facilitates corrective action by operator and maintenance personnel. A QMS consists primarily of technical control facility operators (TFC) (and/or radiomen), communications system test equipment, a system data base, and test procedures. The QMS determines the performance of the communications system and each piece of equipment. The QMS is supported by information from the Planned Maintenance System (PMS), from the Electronic Warfare System (EWS), and from circuit and equipment users.

### 2.1.1 Testing

Testing is accomplished through interjection of test signals and comparison of output results against prescribed operating standards to determine circuit or equipment performances.

### 2.1.2 Monitoring

Monitoring is the observing and checking of communications equipment and circuits using existing signals and comparing measurement results against prescribed operating standards to determine end-to-end circuit performance.

### 2.1.3 Circuit

A circuit (MIL-STD-188-120) is the complete path between two end-terminal instruments over which one-way or two-way communications may be provided. It is also an electronic path between two or more points capable of providing a number of channels.

A QMS is required to perform communication system performance evaluations. The electronic path is considered to be from own ship to another station(s). Anything less is considered equipment or strings of equipment.

### 2.1.4 Equipment

Equipment is any portion of a circuit (less than a total circuit) down to the replaceable unit level. The smallest unit level is generally, but not limited to, the unit size which is transferred to and from preventative maintenance for service.

## 2.2 TESTING AND MONITORING MODES

Four testing and monitoring modes exist based on two fundamental considerations:

1. There is a clear distinction between testing and monitoring being performed on equipment (mainly own ship equipment) versus those performed on end-to-end circuits. In the measurement of a circuit, or the measurement of every equipment in a circuit, either one alone is not a complete indication of the performance capabilities of the other. Faulty equipment may allow satisfactory circuit performance since other equipment in the chain

may compensate to keep total circuit margin limits from being exceeded. Similarly, satisfactory equipment indications may not indicate faulty circuits due to incomplete measurements of the equipment and of the transmission media.

2. The test condition that distinguishes whether it is being performed on-line or off-line determines the manner in which tests are performed and can place restrictions on the completeness of the QMS function.

### 2.2.1 On-line Circuit Performance Testing/Monitoring

On-line end-to-end circuit performance testing/monitoring is the analysis of signal samples to determine communication circuit performance while the circuit is in use. The signal samples are processed to obtain quantitative values of performance parameters that are then compared to preestablished criteria to determine overall circuit performance (satisfactory, marginal, or fault). On-line circuit testing/monitoring shall not interfere with operational use.

### 2.2.2 Off-line Circuit Performance Testing/Monitoring

A QMS allows a technical control facility operator to determine end-to-end circuit performance immediately prior to its release to the user and to periodically verify the performance of backup circuits. This function is part of what is presently referred to as operational readiness testing.

### 2.2.3 On-line Equipment Performance Testing/Monitoring

On-line equipment performance testing/monitoring is the measuring and comparing of the input and output signals of each piece of equipment, or own ship strings of interconnected equipment and include the use of built-in test equipment to determine the performance of each piece of communications equipment (i.e., each piece in the circuit, including the media) while in operational use. The testing/monitoring shall not interfere with operational use.

### 2.2.4 Off-line Equipment Performance Testing/Monitoring

Off-line equipment performance testing/monitoring is the interjection of test signals into each equipment or own ship string of equipment including the use of built-in test equipment for comparison of the output signal(s) against preestablished equipment performance standards. Off-line equipment testing and monitoring allows greater flexibility in designing test and monitor procedures, and allows greater capability to measure performance and isolate faults.

## 2.3 CIRCUIT AND/OR EQUIPMENT PERFORMANCE STATUS

The following performance status conditions may be applied to either end-to-end circuits or to specific equipments.

### 2.3.1 Satisfactory

Performance is within the design and operating specifications. When applied to circuit testing and monitoring, means end-to-end communications are not impaired.

### 2.3.2 Marginal

Performance is between the satisfactory and fault design and operating specifications. When applied to circuit testing and monitoring, end-to-end communications is possible but is impaired to some degree.

### 2.3.3 Fault

Performance is outside the design and operating specifications. When applied to circuit testing and monitoring, usable end-to-end communications is not possible.

## 2.4 INDIVIDUAL PARAMETER MEASUREMENT AUTOMATION LEVELS

### 2.4.1 Manual Measurement

A parameter measurement that requires manual manipulation of test and communications equipment controls, interconnection of equipment, and interpretation of test results.

### 2.4.2 Automated Measurement

A parameter measurement is performed and analyzed by automatic testers, controllers, and processors. Limited manual manipulation may be required to interface with controller or processor for initiation of testing, prompting, and acceptance of test results.

## 2.5 QMS AUTOMATION LEVELS

QMS testing and monitoring levels include manual, semi-automated and fully automated.

### 2.5.1 Manual QMS

Most functions are manual measurements performed by the TCF operator. Nearly all phases of the operations are TCF operator-intensive and demands considerable skill. Manual QM systems are exemplified by the QM systems presently in Navy shipboard use.

### 2.5.2 Semi-Automated QMS

Determination of system performance and fault isolation is accomplished through computer aided functions with assistance from the TCF operator, such as providing access and interpretation of measurement results.

### 2.5.3 Automated QMS

Most determinations of system performance, fault isolation and results are accomplished through automatic access, measurements and display, requiring no operator interface. Operator queries are permissible.

## 3. GENERAL QMS OPERATING FUNCTIONS

The QMS is an aid to the Technical Control Facility operator in determining the performance of communications circuits/systems and equipments. It is also an aid for determining and making correct equipment control settings, making correct equipment interconnections, for conducting trend analysis of circuit/equipment operating parameters to detect degradation prior to failure and for localizing and identifying faulty and marginal equipment.

Circuit determinations and equipment determinations each have three levels of performance: satisfactory, marginal or fault. In any given circuit, any one of nine possible performance states (table 1) are possible, ranging from circuit fault with one or more equipment faults to circuit satisfactory with all equipments satisfactory. Even the less likely cases of circuit fault with all equipment satisfactory or circuit satisfactory with one or more equipment faults can occur and must be dealt with:

1. Circuit Fault, Equipment Fault.
2. Circuit Fault, Equipment Marginal.
3. Circuit Fault, Equipment Satisfactory.
4. Circuit Marginal, Equipment Fault.
5. Circuit Marginal, Equipment Marginal.
6. Circuit Marginal, Equipment Satisfactory.
7. Circuit Satisfactory, Equipment Fault.
8. Circuit Satisfactory, Equipment Marginal.
9. Circuit Satisfactory, Equipment Satisfactory.

Table 1. Circuit and equipment potential conditions.

The QMS determinations are made under two conditions: off-line and on-line. When off-line, a full range of testing and monitoring can be performed, even to determining the points at which operating failure occurs. Only limited on-line testing and monitoring of equipments and circuits is possible since any interruption of normal operations is prohibited. This restricts on-line testing to those parameters that can be monitored while the channel is being utilized.

The QMS circuit and equipment performance determinations present Technical Control Facility operator with a variety of information as to the occurrence, the nature and the location of any marginal or faulty conditions. Based on the QMS results, standard operating procedures, the tactical situation, and the capability for timely corrective action, supervisory personnel make decisions whether or not to take corrective action and whether or not to switch from on-line status to off-line status. The tactical situation and the choices for timely corrective action may, for example, dictate that on-line testing is required even though the circuit might be marginal and/or one or more equipments might be marginal.

Corrective action can take a variety of forms such as equipment repair, equipment replacement, alternate circuit selection, or even requests that the other station perform tests on their equipment and perhaps take corrective action. Entry into QMS operations is normally by way of having received orders to establish one or more circuits. (QMS is also applicable to circuits/equipments in standby status.) Following a circuit request, equipments are then identified, interconnected, and tuned/adjusted/aligned in preparation for operational use. The order in which circuit or equipment performance determinations are then made is optional depending upon whichever is most efficient. However, when complete, the circuit and each equipment within that circuit will combine to make one of the nine possible basic status determinations.

It is possible and in some cases desirable to omit either a circuit or an equipment determination. When only one is made without the other, the combined determination is that both are the same. For example, a faulty equipment indication, without a circuit determination, would assume that the circuit was also faulty.

In each case when a determination and a decision is made the information concerning that determination is carried to the next determination and is used to aid in that decision. This information is further carried on to aid in the taking of corrective action.

The sequence of QMS testing and monitoring functions, for both operational states, and their interaction with operational and corrective action decisions are shown in the flow chart in figure 1.

Table 2 provides examples of circuit and/or equipment conditions, under either off-line or on-line testing mode, and action required.

| ON-LINE – OFF-LINE TESTING | •CIRCUIT STATUS | EQUIPMENT STATUS | ACTION REQUIRED |
|---|---|---|---|
| 1. Off-Line | Satisfactory | Satisfactory | None |
| 2. Off-Line | Marginal | Satisfactory | Take corrective action if system not required for operations. |
| 3. Off-Line | Satisfactory | Marginal or fault | Take corrective action if system not required for operations. |
| 4. Off-Line | Fault | Satisfactory, Marginal or Fault | Take corrective action |
| 5. On-Line | Fault | Satisfactory | Off-Line testing or monitoring no equipment problems found on-line. |
| 6. On-Line | Fault | Marginal or Fault | Make decision whether or not to attempt On-Line corrective action. |
| 7. On-Line | Marginal | Satisfactory, Marginal or Fault | If On-Line corrective action(s) can't be taken, the circuit operational needs must be considered prior to any Off-Line corrective action decision. |
| | Satisfactory | Marginal or Fault | |
| 8. On-Line | Satisfactory | Satisfactory | No action required except periodic testing |

Table 2. Circuit/equipment condition and mode of testing to determine action required.

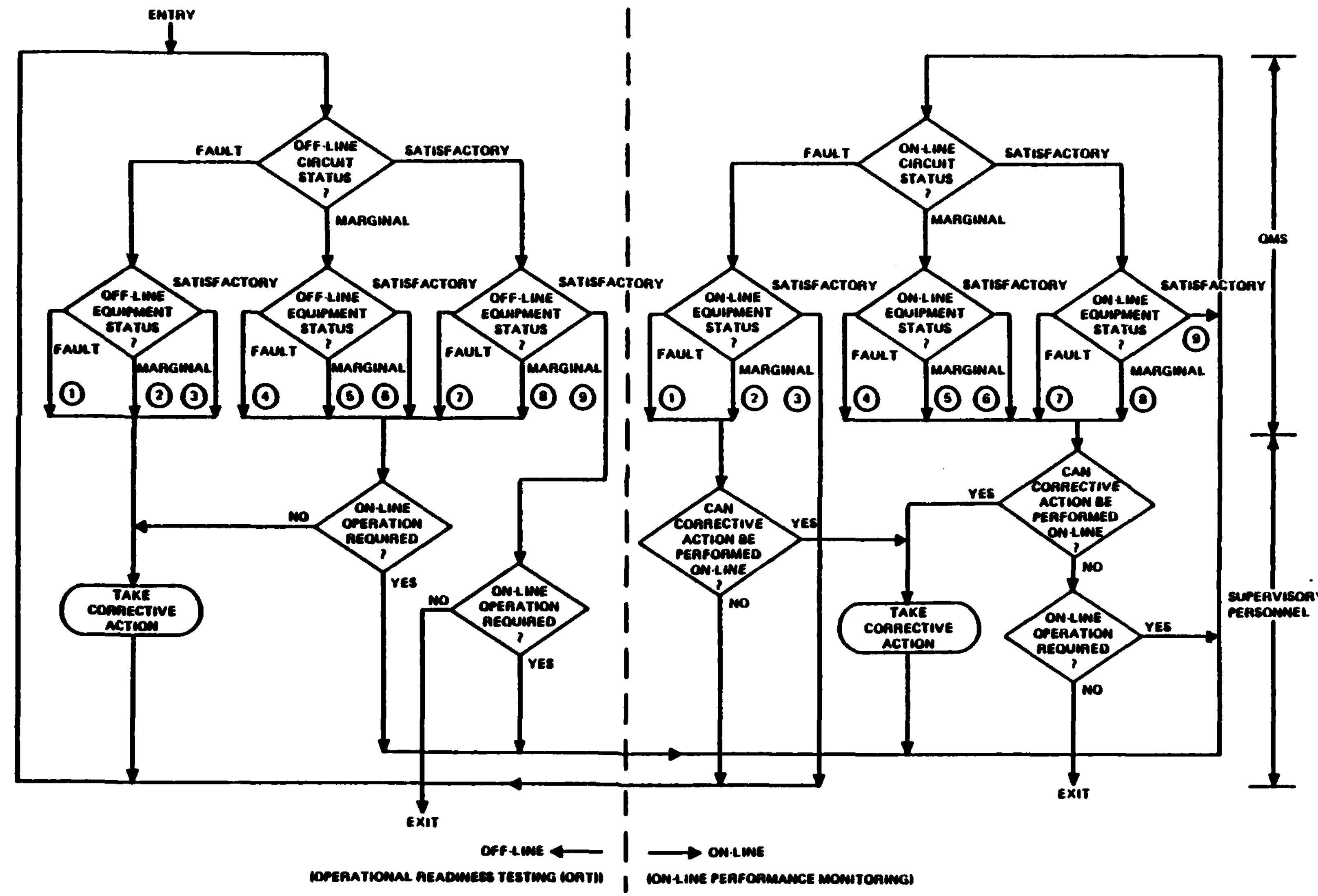


Figure 1. QMS functions within technical control facility operations.

## 4. MEASUREMENT PARAMETERS

Table 3 contains the parameters which characterize the performance of nearly every shipboard communications circuit and equipment. These were developed by analysis of the fundamental parameters needed to determine the performance of each piece of communications equipment and each circuit in current shipboard use. The list was compared against those used in existing and development QMS and in communication system standards. (Some end-to-end circuit parameters, clock associated w/synchronous signals, time standards and some facsimile parameters may need to be added to the list, in future revisions.)

These parameters, if properly measured, will provide an overall QMS capability to determine ship's communications circuit operation and equipment performance. The parameters are to be measured, when applicable, on each particular circuit. They are listed by functional grouping, transmit or receive, and signal or support. The signal parameters are further listed in order of associated equipment, from antenna to user terminal. No indication of degree of usage or relative importance is provided in this list. The parameters are divided into six groups, transmit RF, transmit baseband, receive RF, receive baseband, transmit Support and receive Support. Each of the groups has a list of detailed parameters. Where necessary, a third level of parameters are provided for a more detailed requirement. This grouping is necessary to insure that all equipments are measured and to determine the thoroughness with which the parameters determine each equipment and each circuit performance.

The term baseband, in its strictest context, refers to the spectral content of a signal before it is modified by any form of modulation. With this definition the baseband signals from computers or teletypewriters are the DC bias voltages (or currents) used to distinguish "one's" from "zero's." This switching signal is then typically modulated at some low frequency (or frequencies) prior to RF modulation at the transmitter. For purposes of this document the term baseband refers to either the properties of the DC switching signal or the signal generated by the low frequency modem(s).

The following lists contain a baseband-RF categorization. This was done for purposes of clarification. Also, some of the parameters are listed in both subgroupings. This was done to show that a choice exists as to where the measurements might be made and does not suggest that redundant measurements be made or that a preferential measurement point exists.

**TRANSMIT SIGNAL PARAMETERS (RF)**

1. Effective Radiated Power
    - 1.1 Antenna Performance
        - 1.1.1 Power Gain
        - 1.1.2 Standing Wave Ratio
    - 1.2 Antenna Tracking
    - 1.3 Transmit Coupler Performance
        - 1.3.1 Coupler Loss
        - 1.3.2 Standing Wave Ratio
    - 1.4 RF Output Power

Table 3. Measurement Parameters.

2. Transmit Modulation
   2.1 Modulation Presence
   2.2 Modulation Amplitude
      2.2.1 AM: Percent Modulation
      2.2.2 FM: Deviation
      2.2.3 SSB:
         2.2.3.1 Power
            2.2.3.1.1 Average
            2.2.3.1.2 Peak Envelope
            2.2.3.1.3 Tone/Mark-Space/Channel
         2.2.3.2 Carrier Suppression
      2.2.4 FSK, FDM/FSK, PSK, ETC
   2.3 Bandwidth
3. Transmit Noise and Distortion
   3.1 Harmonic Distortion
   3.2 Intermodulation Distortion
   3.3 RF Signal-to-Noise Ratio
4. Transmit Frequency
   4.1 Carrier
   4.2 Tone/Mark-Space/channel

<u>TRANSMIT SIGNAL PARAMETERS (BASEBAND)</u>

1. Transmit Data Transfer Rate
2. Transmit DC Distortion (includes Bias Distortion)
3. Transmit Encryption
4. Transmit DC Voltage and Loop Current
5. Transmit Baseband Signal
   5.1 Amplitude
      5.1.1 Composite
      5.1.2 Tone Level
   5.2 Phase Shift
   5.3 Tone Frequency/Shift
   5.4 Distortion
   5.5 Bandwidth
6. Message Acknowledgement

Table 3. Measurement Parameters (Contd).

**TRANSMIT SUPPORTING PARAMETERS**

1. Circuit Activity
   - 1.1 Keyline
   - 1.2 Signal Presence
2. Transmit Equipment Temperature
   - 2.1 Overtemperature
   - 2.2 Cooling Water Loss
   - 2.3 Cooling Water Overtemperature
   - 2.4 Cooling Air Loss
   - 2.5 Cooling Air Overtemperature
3. Transmit Coupler Operation
   - 3.1 Loss of Primary Power
   - 3.2 Excessive Temperature
   - 3.3 Excessive Tuning Time
   - 3.4 Failure to set-up
4. Primary Power
   - 4.1 Voltage
   - 4.2 Frequency
5. Connectivity of Equipments
6. Equipment Control Settings

**RECEIVE SIGNAL PARAMETERS (RF)**

1. System RF Power Sensitivity
   - 1.1 Antenna Gain
   - 1.2 Antenna Tracking
   - 1.3 Multicoupler Loss
   - 1.4 Receiver Sensitivity
     - 1.4.1 Minimum RF Signal Sensitivity
     - 1.4.2 Maximum RF Signal Sensitivity
     - 1.4.3 AGC Response Time
     - 1.4.4 Dynamic Range
2. Receive Noise and Distortion
   - 2.1 Atmospheric Noise Amplitude
   - 2.2 Intermodulation Amplitude
   - 2.3 Interfering Signals Amplitude
3. Receive RF Frequency
   - 3.1 Carrier
   - 3.2 Tone/Mark-Space/Channel

Table 3. Measurement Parameters (Continued).

4. Receive signal-to-noise ratio.

5. Receive Squelch Level.

**RECEIVE SIGNAL PARAMETERS (BASEBAND)**

1. Receive Data Transfer Rate
2. Receive DC Distortion (Includes Bias Distortion)
3. Receive DC Voltage and Loop Current
4. Receive Baseband signal
   - 4.1 Amplitude
     - 4.1.1 Composite
     - 4.1.2 Tone level
   - 4.2 Phase Shift
   - 4.3 Tone Frequency Shift
   - 4.4 Distortion
   - 4.5 Bandwidth
5. Receive Decryption
   - 5.1 Decryption
   - 5.2 Crypto Synchronization (includes time start)
6. Receive Signal Intelligibility
   - 6.1 Digital Intelligibility
     - 6.1.1 Bit Error Rate
     - 6.1.2 Character Error Rate
     - 6.1.3 Message Error Rate
   - 6.2 Voice Intelligibility
7. Message Acknowledgement

**RECEIVE SUPPORTING PARAMETERS**

1. Receive Circuit Activity, Signal Presence
2. Receiving Equipment Temperature
   - 2.1 Overtemperature
   - 2.2 Cooling Air Loss
   - 2.3 Cooling Air Overtemperature
3. Primary Power
   - 3.1 Voltage
   - 3.2 Frequency
4. Connectivity of Equipment
5. Equipment Control Settings

Table 3. Measurement Parameters (Continued).

## 4.1 PARAMETER DEFINITIONS AND PURPOSES

Definitions of the measurement parameters were derived from communications standards (particularly MIL-STD-188-120), QMS documents (see Volume 2), and communication engineering practices. The definitions for the parameters and brief statements as to their purpose are presented in Volume 2 as an aid to understanding the significance of each parameter.

## 4.2 PARAMETER TOLERANCES

In today's communications standards, satisfactory and fault performance conditions are documented. Marginal performance levels are not well documented, therefore the tolerance listed in table 4 and in section 6 of volume 2 are provided for guidance in determining measurement capabilities of QM systems.

RECEIVE

| | |
|---|---|
| Sys RF Pwr Sens | |
| Ant Gain | IAW equipment specifications. |
| Ant Tracking | IAW equipment specifications. |
| Multicplr Loss | IAW equipment specifications. |
| Sensitivity | IAW equipment specifications. |
| Min RF Sig Sens | IAW equipment specifications. |
| Max RF Sig Sens | IAW equipment specifications. |
| AGC Response Time | IAW equipment specifications. |
| Dynamic range | IAW equipment specifications. |
| Noise & Distortion | |
| Atmospheric Noise Amp | Not available at this time. |
| Intermod Amplitude | 35dB below Peak signal |
| Interfering Sig Amp | 35dB below Peak signal |
| RF Freq | |
| Carrier | * |
| Tone/Mark-Space/Chnl | ** |
| SNR | 15:1 |
| Squelch Level | IAW equipment and ckt specs. |
| Data Transfer Rate | IAW established ckt data rate. |
| DC Distortion | Black: Max 15%, Red: Max 5%. |
| DC volt/loop current | High: 60 MA ±1 MA, Low: +6 Vdc/-6 Vdc ±1V |
| Baseband Signal | |
| Amplitude | *** |
| Composite | **** |
| Tone level | All chnls within ±1.5dB |
| Phase Shift | Not available at this time. |
| Tone Freq. Shift | ***** |
| Distortion | Not available at this time. |
| Bandwidth | IAW type of emission |
| Decryption | |
| Decryption | |
| Crypto Sync | IAW equipment specifications. |
| Sig Intelligibility | |

TRANSMIT

| | |
|---|---|
| Eff Radiated Pwr | |
| Ant Performance | IAW equipment specifications. |
| Pwr Gain of Ant | IAW equipment specifications. |
| SWR | Hf range - Maximum 2.0 to 1. |
| Ant Tracking | IAW equipment specifications. |
| Cplr Performance | IAW equipment specifications. |
| Cplr Loss | IAW equipment specifications. |
| SWR | Not available at this time. |
| Xmtr RF Output Pwr | IAW ckt, equip specs and mode of op. |
| Modulation | |
| Modulation Presence | IAW ckt rqmts. |
| Modulation Amplitude | |
| AM: % Modulation | IAW ckt rqmts. |
| FM: Dev | Max deviation 40 Khz. |
| SSB: | |
| Power | IAW equipment specifications. |
| Avg. | IAW equipment specifications. |
| PEP | IAW equipment specifications. |
| Tone/Mk-Sp/Chnl | IAW equipment specifications. |
| Carrier Supprsn | 40dB below Peak signal |
| FSK, FDM/FSK, PSK, etc | IAW equipment specifications. |
| Bandwidth | IAW mode of xmission. |
| Noise & Distortion | |
| Harmonic Distortion | 35dB below fundamental frequency. |
| Intermod Distortion | -35dB below maximum peak signal |
| RF SNR | +40dB minimum. |
| RF Freq. | |
| Carrier | * |
| Tone/Mk-Sp/Chnl | ** |
| Data Transfer Rate | IAW established ckt data rate. |
| DC Distortion | 5% maximum. |
| Encryption | IAW equipment and ckt specs. |
| DC volt/loop current | High: 60 MA ±1 MA, Low: +6 Vdc/-6 Vdc ±1V |

Table 4. Parameter tolerance summary.

| | |
|---|---|
| Digital Intel | |
| Bit Error Rate | CP Term. $10^{-6}$, Digvox $10^{-3}$ |
| Character Err Rate | Not available at this time. |
| Message Err Rate | Not available at this time. |
| Voice Intelligibility | |
| Message Acknowledgement | |
| Ckt Acty. Sig Pres | IAW equipment and ckt specifications. |
| Equip Temp | |
| Overtemp | IAW equipment specifications. |
| Cooling Air Loss | IAW equipment specifications. |
| Cooling Air Overtemp | IAW equipment specifications. |
| Primary Power | |
| Voltage | ±5% |
| Frequency | ±5% |
| Connectivity of Equip | |
| Equip Control Settings | IAW equipment and ckt specs. |

* Cw/AM Voice ±200 Hz, SSB Voice ±100 Hz, Single Chnl AFTS/RFCS RATT ±25 Hz, Multichnl AFTS RATT ±4 Hz, Data/digital Voice ±2 Hz.

** Single Chnl AFTS/FSK RATT ±25 Hz, Multichnl AFTS RATT ±4 Hz, Data/digital Voice ±2 Hz.

*** Voice -5 dBm to -25 dBm, Single Chnl FSK 0 dBm ±3 dBm, Multichnl AFTS RATT -10 dBm ±3 dBm.

**** Voice -10 VU ±3 VU, Single Chnl FSK 0 dBm ±3 dBm, Multichnl AFTS RATT -10 dBm ±3 dBm.

***** FSK 850 Hz ±50 Hz, 170 Hz ±30 Hz.

IAW – In accordance with.

| | |
|---|---|
| Baseband Signal | |
| Amplitude | |
| Composite | *** |
| Tone Level | All chnls within ±1.5 dB |
| Phase Shift | Not available at this time. |
| Tone Freq. Shift | ***** |
| Distortion | 40 dB below desire sig |
| Bandwidth | IAW type of emission |
| Message Acknowledgement | Intelligibility/readability |
| Ckt Activity | |
| Keyline | Keyed/Unkeyed |
| Signal Presence | IAW mode of op and equip specs. |
| Equip Temp | |
| Overtemp | IAW equipment specifications. |
| Cooling Water Loss | IAW equipment specifications. |
| Cooling Water Overtemp | IAW equipment specifications. |
| Cooling Air Loss | IAW equipment specifications. |
| Cooling Air Overtemp | IAW equipment specifications. |
| Coupler Operation | |
| Loss of Primary Pwr | IAW equipment specifications. |
| Excessive Cplr Temp | IAW equipment specifications. |
| Fail to set up | |
| Primary Power | |
| Voltage | ±5% |
| Frequency | ±5% |
| Connectivity of Equip | |
| Equip Control Settings | IAW equipment specs and ckt specs. |

Table 4. Parameter tolerance summary. (Continued)

# 5. AUTOMATION REQUIREMENTS

## 5.1 BACKGROUND INFORMATION AND GENERAL COMMENTS

Because of fleet support requirements, the Navy uses more radio path circuits than any other military service. In spite of this fact, the Navy has developed little capability to monitor system/circuit operation and to provide rapid fault isolation services. In addition, computer-aided message processing systems, NAVMACS V2, SSIXS, CUDIXS and others under development now provide the means to handle a much greater volume of traffic and data flow than before. Satellite systems provide the means to deliver the data to these systems at tremendous speeds, up to 2400 baud, compared to the typical 75 baud speed via hf radio circuits.

In the past, short circuit outages resulted in the loss and retransmission of relatively few messages. At the high information transfer rates, short outages will result in the loss of many messages which will be a serious threat to effective command, control, and communications. Voice circuits are also being adapted to the digitized systems via the satellite systems using 2400 bps vocoders. These high data rate circuits employ modulation schemes (Phase Shift Keying, Pulse Duration Modulation, etc.) which are more critical to frequency, power and timing. They must meet a more rigid set of signal parameters to perform satisfactorily.

In order for the Navy to meet these requirements, new quality testing and monitoring capabilities and procedures must be developed. They must also increase their capabilities to maintain the existing radio circuits operating at optimum performance in order to help achieve the Navy command control and communications ($C^3$) objectives to provide common-user service to all military subscribers through the establishment of a unified $C^3$ network structure. The shortcomings of today's quality monitoring systems and procedures are:

- Minimum on-line performance monitoring,
- Minimum monitoring capabilities to monitor more than one circuit at one time,
- Imprecise fault data, and
- Time consuming test equipment setup and readings.

These shortcomings result in the situation that the circuits are either "IN" or "OUT" and technical control facility operators rely heavily on the users to inform them of circuit problems. This is unacceptable in maintaining the new high data rate circuits. The Navy must provide the capability to rapidly detect degradation in a system/circuit and allow the operator to take corrective action before loss of communication occurs. The Navy must also provide logical fault isolation procedures and techniques for rapid restoral of circuits and equipment.

In order to help achieve these goals parameters required for measurements in determining circuit/equipment malfunction of today's and future communication systems were defined, as presented in section 4. The Navy must increase the effectiveness of quality monitoring by measuring these parameters effectively and efficiently.

The recommendation is to automate measurement of the signal parameters which are most critical in order to maintain optimum performance of today's and future systems/circuits. Cyclic quality monitoring, logical steps for fault isolation and circuit testing, can be accomplished with today's advanced automation technology. The philosophy to automate simply because the signal parameters are easy to automate will not provide effective quality monitoring. All the parameters listed in section 4 are important, but some are more important than others when evaluating system/circuit performance against performance standards. Which signal parameters are most important and which ones should be automated? *To determine the relative importance of each parameter listed in section 4, a prioritization process was used and is discussed in the next section.

## 5.2 PRIORITIZATION APPROACH

In determining the importance of each signal parameter listed in section 4, shipboard experience, fleet input and engineering technical rationale were employed in the prioritization process. The signal parameters are separated into two categories, transmit signal parameters, and receive signal parameters which include transmit and receive supporting parameters.

Prioritization of the measurement parameters in order of importance was accomplished by utilizing table 2 Volume 2 and evaluating the value of each parameter when measured and used during the following testing/monitoring modes:

- Off-line Circuit Testing/Monitoring
- On-line Circuit Testing/Monitoring
- On-line Equipment Testing/Monitoring
- Off-line Equipment Testing/Monitoring

For each mode of testing/monitoring, the following were considered and a numerical value assigned to each parameter (the lower the numerical value, the higher the priority of importance):

- How critical is the measurement of this parameter for each test?
- How sensitive is the parameter to circuit/equipment performance standards?
- What is the frequency of outages caused by failure of this parameter?
- What is the required frequency of measurement of this parameter?
- Is the measurement of this parameter an overlap or a redundant measurement?
- Is the measurement of this signal parameter common to all types of shipboard circuits/equipments?
- Is the measurement of this parameter meaningful?

All four numerical values for each parameter were totaled and the average value was used to determine the relative overall importance of the parameter. For example, TRANSMIT CARRIER FREQUENCY has assigned numerical values of 3, 7, 6 and 8. These numerical values average 6. TRANSMIT AUDIO SIGNAL AMPLITUDE has assigned numerical values of 6, 8, 8, and 4. These average 6.5. So TRANSMIT CARRIER FREQUENCY would be of higher importance than TRANSMIT AUDIO SIGNAL AMPLITUDE. The parameters were then grouped into three categories:

1. Highest importance and recommended for automated measurement.
2. Lesser importance and recommended for manual measurement.

*These parameters were initially analyzed using the three levels of QMS automation, manual, semi-automatic, and automatic to determine the type of measurement (manual or automatic) required for each parameter. Volume 2 provides the preliminary judgement of the level of automation required for the measurement of these parameters in determining equipment/circuit performance.

The determination as to which parameters were to be candidates for automated and manual measurements was based on the overall numerical value and priority assigned to each parameter in Volume 2. Using the overall numerical value assigned, two lists of parameters were established in order of priority, one for transmit parameters and one for receive parameters. The lists were evaluated for the priority assigned and the division between automated and manual measurements was determined by the trend of the numerical value and priority assigned and the difference in value between consecutive parameters. For example, in the TRANSMIT SIGNAL PARAMETERS, the most important parameter according to the overall numerical value is TRANSMIT EFFECTIVE RADIATED Power with a numerical value of 3.83. The numerical values and priority assigned to the next successive parameters are 5.25, 6, 6, 8.64, 8.75, 9 and then jumps to 12.25, 13.5, 14.5 and 14.7. As noted, there is a significant difference in value and trend between the 9 and the 12.25 which indicates a gap in the relative importance, therefore parameters with a numerical value of 9 and below are listed in table 5 for automated measurements. The parameters with a numerical value of 12.25 and above are listed in table 6 for manual measurements. Similarly, receive parameters were evaluated and divided using the same method as for transmit parameters.

The parameters recommended for automation will enable rapid detection of circuit or equipment degradation and fault isolation and rapid meeting of the demands to maintain shipboard circuits and equipment functioning within operating standards.

The parameters recommended for manual measurement could be automated but the measuring of these parameters manually will suffice in keeping systems/circuits operating within standards without seriously affecting the overall efficiency of quality monitoring.

Volume 2 lists the recommended automation of the parameters prioritized within this section, with additional comments.

## 5.3 RECOMMENDATIONS FOR AUTOMATIC AND MANUAL MEASUREMENTS

The parameters recommended for automatic measurement are shown in table 5, and manual measurement in table 6. The parameters are in order of importance within each group, with the most important first.

TRANSMIT SIGNAL PARAMETERS

Transmit Effective Radiated Power (Note 1)

Transmit Message Acknowledgement (Note 2)

Transmit Modulation (Modulation Presence Only) (Note 3)

Transmit RF Frequency.

Transmit Baseband Signal

Transmit DC Distortion

Transmit Noise and Distortion

TRANSMIT SUPPORTING PARAMETERS

Transmit Equipment Temperature

Transmit Coupler Operation

Table 5. Parameters recommended for automatic measurements.

Primary Power

Transmit Circuit Activity

Connectivity of Equipments

RECEIVE SIGNAL PARAMETERS

Message Acknowledgement (Note 2)

Receive System RF Power Sensitivity (Note 4)

Receive Signal to Noise Ratio

Receive DC Distortion

Receive Baseband Signal

Receive RF Frequency

Receive Signal Intelligibility (Note 5)

RECEIVE SUPPORTING PARAMETERS

Receive Equipment Temperature

Primary Power

Receive Circuit Activity

Connectivity of Equipment

Notes:

(1) Power gain of an antenna, a portion of effective radiated power, for both transmit and receive, is presently seldom determined directly by QMS but may be determined either by PMS, or during installation, or not at all. The QMS indirect determination of antenna performance is by a process of elimination. On transmit antennas, the transmitter output is checked, then the multicoupler tuning, and then the antenna VSWR. If communication is still degraded, a comparison is made using a substitute antenna. On receive, a similar checking and substitution process is conducted with the final step being antenna substitution.

(2) Transmit message acknowledgement is presently under the control of the user. In transmit circuits, satisfactory message acknowledgement, may temporarily reduce the need for a determination that all of the other transmit parameters are satisfactory.

Similarly, in receive circuits, satisfactory receive signal intelligibility, may temporarily reduce the need for determinations of the other receive parameters.

If the user is voice or manual TTY, then the message acknowledgement is manual. If the user system is automated, such as MPDS, then automated acknowledgement is possible/available to QMS.

(3) Transmit modulation includes a number of measurements which make up this general category. One of these, modulation presence, was of sufficient importance, relative to transmit modulation to be separated from it and placed in its own position.

(4) The role of switching is presently not under the control of QMS. Today's switching, being manual, causes the level of QMS automation to be at best only partially automated. If automated switching is provided, or even partial automation such as non-interfering bridging, then partial QMS automation is possible.

(5) Receive signal intelligibility is presently performed by the user. If the user is manually operating the circuit, then intelligibility is determined manually. If the user system is automated, with error detection and correction (EDAC), then automated determination of intelligibility is possible/available to QMS.

Table 5. Parameters recommended for automatic measurements. (Continued)

TRANSMIT SIGNAL PARAMETERS

Transmit DC Voltage/Loop current

Transmit Data Transfer Rate

Transmit Encryption

Transmit Modulation Amplitude (excluding Modulation Presence)

TRANSMIT SUPPORTING PARAMETERS

Equipment Control Settings

RECEIVE SIGNAL PARAMETERS

Receive DC Voltage/Loop current

Receive Decryption

Receive Data Transfer Rate

Receive Squelch Level

RECEIVE SUPPORTING PARAMETERS

Equipment Control Settings.

Table 6. Parameters recommended for manual measurements.

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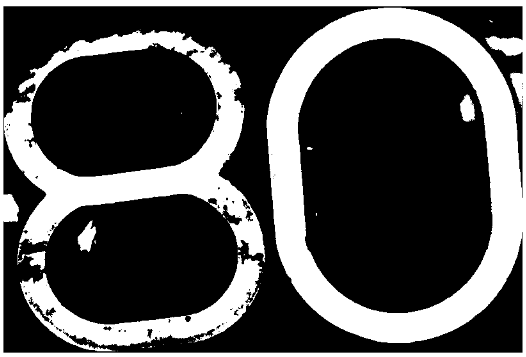
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