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AUTOMATION APPLICATIONS IN AN ADVANCED AIR TRAFFIC MANAGEMENT SYSTEM
Volume III: Methodology for Man-Machine Task Allocation

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16. Abstract

The Advanced Air Traffic Management System (AATMS) program is a long-range investigation of new concepts and techniques for controlling air traffic and providing services to the growing number of commercial, military and general aviation users of the national airspace. This study of the applications of automation was undertaken as part of the AATMS program. The purposes were to specify and describe the desirable extent of automation in AATMS, to estimate the requirements for man and machine resources associated with such a degree of automation, and to examine the prospective employment of humans and automata as air traffic management is converted from a labor-intensive to a machine-intensive activity.

Volume III describes the methodology for man-machine task allocation. It contains a description of man and machine performance capabilities and an explanation of the methodology employed to allocate tasks to human or automated resources. It also presents recommended allocations of tasks at five incremental levels of automation.

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1.0 PREFACE

1.1 ADVANCED AIR TRAFFIC MANAGEMENT SYSTEM STUDY

This report is one of a series produced by the TRW-Planar group in a study of automation applications for an Advanced Air Traffic Management System (AATMS), work performed for the Department of Transportation, Transportation Systems Center (DOT/TSC) under contract number DOT-TSC-512. The reports in this series are:

- Automation Applications in an Advanced Air Traffic Management System - Volume I, Summary. TRW Report No. 22265-W008-RU-00, December 1973.

  This is a summary document, stating the background and objectives of the study and describing the major study results. It also contains a discussion of the implications of the results for an advanced air traffic management system and a suggested strategy for implementation of automation.

- Automation Applications in an Advanced Air Traffic Management System - Volume II, Function Analysis of Air Traffic Management. TRW Report No. 22265-W006-RU-00, December 1973.

  This volume provides an analysis and description of air traffic management activities at three levels of detail - functions, subfunctions, and tasks. A total of 265 tasks are identified and described, and the flow of information inputs and outputs among the tasks is specified.

- Automation Applications in an Advanced Air Traffic Management System - Volume III, Methodology for Man-Machine Task Allocation. TRW Report No. 22265-W007-RU-00, December 1973.

  This volume contains a description of man and machine performance capabilities and an explanation of the methodology employed to allocate tasks to human or automated resources. It also presents recommended allocations of tasks at five incremental levels of automation.

- Automation Applications in an Advanced Air Traffic Management System - Volume IV, Automation Requirements. TRW Report No. 22265-W009-RU-00, December 1973.

  This volume is a presentation of automation requirements for an advanced air traffic management system in terms of controller work force, computer resources, controller productivity, system manning, failure effects, and control/display requirements. It also includes a discussion of the application of the study results to the design and development of AATMS.

- Automation Applications in an Advanced Air Traffic Management System - Volume V, DELTA Simulation Model. TRW Report No. 22265-W010-RU-00, December 1973.

  This volume includes all documentation of the DELTA (Determine Effective Levels of Task Automation) computer simulation developed by TRW for use in the Automation Applications Study. The volume includes a user manual, programmers manual, test case, and test case results.

The results which have been documented in these volumes represent a team effort. However, it is most appropriate to recognize the contributions of the following individuals who were responsible for major elements of the study:

Mr. R. Jones	TRW	Volume II, Functional Analysis
Mr. L. Jenney	The Planar Corp.	Volume III, Man-Machine Allocation Methodology and Volume IV, Failure Modes and Displays
Mr. E. C. Barkley	TRW	Volume V, DELTA Simulation
Mr. K. Willis	Metis Corp.	Volume V, Algorithm Development

1.2 SUMMARY OF VOLUME III

The man-machine allocation methodology employed in the Automation Applications Study was developed in response to the need for objective and quantifiable technique to assign air traffic management tasks to human and computer resources. The immediate objective was to examine each of the 265 generic air traffic management tasks identified during the study and to document the rationale for allocating these tasks to men or machines at successively more advanced levels of automation. These allocations and the task analysis itself were intended to serve as the basis for a detailed study of automation applications in AATMS. A second, and broader, purpose of the methodology developed here was to provide a more systematic approach and an objective, repeatable procedure for relating man-machine performance capabilities to tasks in the design of complex systems. Thus, the methodology employed in this study, while devised primarily to serve the needs of the AATMS study, also provides a general purpose tool for human factors and systems engineering.

The man-machine allocation methodology represents a synthesis of three separate disciplines - systems engineering, human factors, and psychometrics. At the beginning of the study an extensive review was made of systems design and human factors research literature pertaining to man-machine performance. (A compilation of the findings is presented in Appendix A of the report.) This survey formed the basis for construction of six performance capability scales by which to evaluate each of the 265 air traffic management tasks.

The evaluation was carried out in four steps. First, each task was analyzed to determine which of the six basic performance capabilities were required to accomplish the task. Next, a group of thirty-two judges with experience in systems analysis, human factors, computer applications, or air traffic control were asked to assign a numerical rating to each task for each of the required performance capabilities. These ratings, over 22,000 individual data points, were then aggregated across judges and performance capabilities to obtain an index of automation priority for each task. As a final step, the tasks were assigned to one of five incremental levels of automation according to this index.

This volume contains a detailed description of the methodology outlined above. It begins with a summary of the general problem of man-machine allocation and a review of the available methodology. This is followed by an account of the method by which performance capability scales and man-machine performance rating instruments were developed. Next is a description of data collection procedures and a discussion of the statistical techniques used to reduce the data to a composite automation index for each task. Five levels of system automation are quantitatively defined; the characteristics of each level are described; and the relationships among successive levels are examined. The report concludes with a discussion of the application of the findings to subsequent analysis of air traffic management system requirements and an assessment of the utility of the methodology in other types of system design and development problems.

2.0 INTRODUCTION

2.1 BACKGROUND

Automation of the air traffic control system has been the subject of extensive study for over twenty years. Historically, automation has been considered the way both to achieve greater safety and capacity in the national aviation system and to lessen the workload of air traffic controllers. More recently, as the demands on the national aviation system have increased, government policy has tended toward the view that automation is not just desirable but mandatory if the system is to continue to provide a level of safety and capacity consistent with the public interest. The developmental effort which has led to the NAS Stage A and ARTS III systems was undertaken with the objective of introducing automation in the enroute and terminal portions of the system. The engineering development of the upgraded Third Generation System and the study of AATMS now being pursued are based on the proposition that still more advanced degrees of automation will be necessary to accommodate anticipated growth in commercial and general aviation while also providing increased safety for airspace users.

In making the transition from the ATC system of today to a more automated system of 1990-2020, there are two central concerns. First, in which parts of the system will automation produce the greatest benefits in terms of safety, capacity, and limiting the growth in ATC costs? Second, in what order should automated features be introduced into the ATC system?

The latter question, the sequence of automation, is important for several reasons. Foremost is that the system must provide continuity of service as it progresses toward its ultimate level of automation. Hence, automation must be introduced in an evolutionary, rather than a revolutionary, way. For economic reasons it is also necessary to spread the process of automation out over several years so that the public and private sectors of the economy can comfortably absorb the RDT&E and O&M costs. Further, since not all of the technology appropriate for advanced levels of automation is presently available, the design and development of the system must be paced incrementally in step with technological progress. Finally, of course, the controllers themselves must be considered. Automation must be introduced gradually to allow men to learn and perfect the new skills required and to provide for an orderly transition from today's controller work force to one of perhaps greatly different size and composition by the year 2000.

The concept of incremental automation is not unique to the AATMS study. Nearly all of the major studies of air traffic control system automation, beginning with such early programs as Data Processing Central in 1960 and National Airspace Utilization System in 1962, have been predicated upon the idea of sequential introduction of automated features. For example, the National Airspace Utilization System report (FAA/SRDS, 1962) referred to an "automation ladder," starting with a wholly manual system and progressing through automated data processing and tracking to computer-aided evaluation and decision-making. In another study undertaken at about the same time (Buckley and Green, 1962), an analysis was made of information processing and display in the air traffic control system; and the authors identified thirteen incremental stages of man-machine function allocation in going from a manual to a "fully automated" system.

More recent studies of ATC automation (e.g., MITRE, 1972) continue to speak of "generations" of systems, meaning a phased and evolutionary introduction of automated features. The basic FAA planning documents (The National Aviation System Policy Summary and The National Aviation System Ten Year Plan) reflect the concept of progressive automation in laying out the program of transition from the manual second generation system to the third generation and eventually to Phases I and II of the Upgraded Third Generation system.

Incremental automation raises two fundamental questions about the nature of man-machine relationships in complex systems. First, on what basis shall the decision to allocate tasks to man or machine be made? This implies that there must be criteria of choice and decision rules. Second, if automation is to proceed step by step, how is the priority for allocation of tasks to machines to be established? This implies that the basic allocation decision has to be quantified in some way which will permit tasks to be arrayed ordinally as a man-machine performance continuum. These two questions, task allocation criteria and automation priorities, are the major methodological problems addressed in this report.

2.2 THE PROBLEM

The problem of allocating tasks to man or machine is as old as the industrial age itself. However, the problem was not attacked systematically until about fifty years ago with the advent of industrial engineering, and it has not been treated as a researchable problem until the last two decades. Initially, investigation centered around the machine as an adjunct to man, i.e., ways were sought to use the machine to supplement or augment man's physical capabilities. Mechanical and electro-mechanical devices which were stronger, faster, more accurate, and more enduring than man were developed and placed at his service. By the 1940's, technology reached the point where machines were also capable of functioning as a partial surrogate for man's intellect, and it became possible to conceive of the machine as a replacement for man in the areas of information processing, evaluation, decision-making, and process control. This technological advance made it practical to think of machines not just as an aid to man but also as a substitute for men.

At the theoretical level, writers such as Wiener, Von Neumann, and Adler examined the implications of cybernetics and "thinking machines." In the field of basic research, investigators such as Fitts, Kidd, Birmingham, and Mackworth undertook basic studies of the respective roles of men and machines in complex systems and formulated principles for the allocation of tasks to men and machines in the system design process. The applied fields of human factors and human engineering received great impetus from this concern for providing designers with practical man-machine allocation guidelines, and many of the now standard human factors reference works (McCormick, Woodson and Conover, Sinaiko, Gagne, et al.) date from this period.

Despite the attention devoted to the principles of man-machine system design in the 1950's and 1960's certain conceptual and practical difficulties remained. Partly they were lodged in the inherent complexity of the systems developed during that period. There was an almost infinite number of permutations and combinations of man and machine tasks available to system engineers, a variety which precluded systematic empirical comparison of alternative designs at any but the most global levels. Without a detailed body of empirical evidence, the essence of the decision on man-machine task allocation remained engineering judgment. Relying upon his experience in system design and fragmentary research evidence, the engineer pursued a strategy of judgment, "best guess," and successive approximations.

Typically, system development in the 1950's and 1960's began with specification of objectives and system performance requirements. Through an iterative process, these requirements were expanded to greater and greater levels of detail to form a prescriptive statement of what each functional component of the system had to do. Drawing upon an increasingly rich pool of technological resources, the engineer then designed an equipment complex to meet these requirements as fully as possible. Where technology was inadequate or where by design philosophy it was considered desirable to preserve man's participation, system functions were assigned to human operators. To support these decisions, system simulations and operational tests were performed; and, where necessary, redesign of equipment was carried out. Optimal human performance was usually provided for by operator selection standards, training, and careful man-machine interface design. Man, because of his great inherent performance capability and his adaptability, entered the system primarily as a means of augmenting and aiding the machine (i.e., as a form of compensation) and only secondarily as a controller or manager of the machine or as a full partner in the system.

More recent design philosophy has tended to view the question of task allocation not as a matter of man or machine but as one of man and machine. That is, human operators and automata are not considered as alternative resources to be traded off during the design process but as elements to be blended in a symbiosis. The basis for an enlightened decision on how to marshal these resources effectively is an accurate characterization of man and machine capabilities. Each process or task in the operation of the system is examined in terms of the performance capabilities required for its accomplishment. If these capability requirements best match the characteristics of machines, the task is automated. If the capability requirements best match human characteristics, the task is assigned to man. If the task falls within the performance domains of both man and machine, the designer can safely opt for either.

For this approach to work effectively, it is necessary to have a comprehensive catalog of man and machine performance characteristics and some form of standardization of the decision process. Two recent and notable attempts to provide such an orderly basis for man-machine allocation decisions are the AFSC Design Handbook series (especially DH 1-3, Personnel Subsystems) and the comprehensive study by Serendipity Associates, A Descriptive Model for Determining Optimal Human Performance in Systems (Serendipity, 1966). Despite the value of these two documents as data sources to support judgments of man-machine allocation, they suffer from a major deficiency. The procedure for applying the data to specific design problems is not precisely defined and standardized. As a result, there is considerable latitude for interpretation and selectivity in using the data to formulate decisions. Thus, while the body of information available to the designer has been enlarged and systematically arranged in these documents, the application of the information is still subject to the vagaries of individual judgment. The methodology developed in the AATMS study and described in this report is an attempt to place man-machine allocation on a more objective basis and to provide a systematic decision-making procedure.

2.3 REVIEW OF AVAILABLE METHODOLOGY

The field of system engineering provides a classic approach to the problem of man-machine task allocation. Typically, the systems analyst begins with a statement of design principles or general desiderata which are to serve as criteria for making individual task allocation decisions. These criterion statements are of diverse origins, but most commonly they are derived from some characterization of an "ideal" system or from engineering and technological considerations. By a process of logical analysis, the criteria are applied to the problem at hand; and, depending upon the analyst's skill and the quality of his judgment, a more or less coherent scheme of man-machine allocation emerges. Two examples will serve to illustrate the method.

In 1959 the FAA conducted a project known as Data Processing Central, which proposed the following guidelines for automation of ATC functions (FAA BRD, 1959).

- Automate routine bookkeeping and coordination functions.
- Automate data display (including updating and tracking).
- Unburden the controller by automating tasks not directly related to decision-making and control.
- Use computers to aid planning and prediction.
- Use computers to aid control of terminal area traffic flow.
- Use computers to aid in the consolidation and integration of flight plan and performance data.

Ten years later, the Autonetics Division of North American Rockwell conducted a similar study of automation applications in air traffic control (Autonetics, 1969). This study outlined the following criteria for man-machine task allocation.

- Ease of Automation - This is a function of computer/software technology and the inherent capabilities of computers.
- Routine Digital Tasks - Computers should be used for tasks involving computation, data handling, parameter sorting, display generation, etc.

- Human Judgment - Human control is desired where judgments or complex decisions must be made.
- Computer Capacity - Retain human control if computer capacity required for the task tends to be large.
- System Interfaces - Computers should be used to exchange information with automated systems which interface with the ATC system (e.g., autopilots, weather data computers).
- Unburdening Manual Operations - Computer aiding of manual tasks should be used, especially for display, data storage, simple comparisons, etc.

It is evident that the two sets of criteria are much alike, being made up of a mixture of system engineering principles, technological concerns, and design objectives. Both lists also make reference to the concept of unburdening the controller by relieving him of routine manual chores.

While there can be no quarrel with these criteria as statements of ideal system features, they do seem inadequate on practical grounds. How, specifically, are these criteria to be applied? Are they to be given equal weight, or are some more important than others? How is one to determine the degree to which specific designs meet these criteria? It is obvious that man-machine task allocation by this method is more of an art than a science and that two different experts, starting from the same premises, might well reach contradictory conclusions. Even a cursory review of the studies of ATC automation conducted in the past few years bears this out, and it is highly probable that the disputes which surround automation in air traffic control stem not from the criteria themselves but from a lack of agreement on how to interpret and apply them.

An alternative to the system engineering approach can be found in the field of human factors, where there is voluminous literature pertaining to man's performance capabilities. During the initial phase of this study a review was made of this research, and a compilation of the major findings was prepared. Primarily, they consist of comparative statements about men and machines and characterizations of human performance of various types of tasks. Cast in the form of criterial statements, this information could be used as the basis for allocating tasks to men or machines.

In effect, this is the same as the system engineering approach, except that the grounds for task allocation are human performance capabilities rather than system engineering and design principles. That is, the allocation decision is still a matter of judgment and interpretation, and all that has been accomplished is a substitution of one type of justification for another. The success or failure of either approach rests solely on the quality of the criteria used and the astuteness of the analyst's judgment in applying them. In fact, since there is so little to choose between the two methods, a preferable course would be to combine the two types of criteria and allocate man-machine tasks on the basis of both.

A method for systematizing and objectifying the decision-making process can be found in the field of psychometrics. The general procedure consists of stating the elements of a decision as a series of questions which can be answered by selecting from a finite, and usually small, set of standard responses. Typically, the responses are ordered to form steps along a continuum, such as Agree-Disagree or Always-Never. Familiar examples of psychometric techniques are the procedures used by public opinion pollsters and the Cooper-Harper rating system used in the aerospace industry to evaluate controls and displays, vehicle handling qualities, and the like.

A more sophisticated and sensitive psychometric technique is that of ratio scaling (or subjective magnitude estimation) developed by the late S. S. Stevens. In a series of experiments Stevens demonstrated that sensory qualities, psychophysical phenomena, and even purely social judgments can be translated into magnitudes. In the psychophysical field Stevens concluded that the basic law is a power function of the form:

$$\Psi = k\phi^n$$

where Ψ = subjective magnitude

ϕ = physical magnitude

n = exponent, derived from the modality or continuum used

k = constant, depending on the unit of measurement

His work suggests that the power function relationship pertains between almost any physical quantity and subjective judgments of that quantity.

Further, in areas where there is no counterpart physical continuum, i.e., where the stimuli can be measured only on a nominal (judgmental) scale, the power law cannot be confirmed directly but still appears to be operative. This is explained by Stevens as follows:

> "For both kinds of continua, those based on metric stimuli and those based on nonmetric stimuli, there is a constant relation between the scale erected by direct judgment and the scale derived from a unitizing of variability or confusion. Whether the stimuli are measurable on ratio scales or only on nominal scales, the judgmental scale based on units of variability is approximately proportional to the logarithm of the scale constructed by one or another of the direct scaling methods. The extensive invariance of this logarithmic relation attests to a principle known throughout all of science--namely, error or variability tends to be relative: the size of the error grows with magnitude. The principle finds expression under many phrasings: the standard deviation increases with the mean; the coefficient of variation remains constant; the signal-to-noise ratio stays put; accuracies are statable as one part in so many. The emergence of a similar canon in the subjective domain, a rule that variability tends to increase in proportion to the apparent magnitude, suggests an essential unity among the principles that govern quantitative relations in widely diverse endeavors. For those who must build their science on one or another consensus of human judgment, a way seems open for effective quantification." (Stevens, 1966)

2.4 APPROACH

The approach adopted for man-machine task allocation in this study was a synthesis of the three major methods outlined in the previous section. Characterizations of man and machine performance, drawn from the two fields of systems engineering and human factors, were used as task allocation criteria. The procedure for applying these criteria in reaching an allocation decision was a modified form of the Stevens magnitude estimation technique. The objective was to create an algorithm for the assignment of tasks either to a human operator or a computer.

The approach rests on two major assumptions. First, it was assumed that the operation of an ATM system could be described as a finite series of tasks and that each task could be defined in terms of specific performance capabilities necessary to its accomplishment. Given a catalog of performance capabilities of man and machine resources, allocation thus became a question of determining which resource was best suited for the task. In other words, the performance requirements inherent in the task determine the suitability of the task to manual or automated means of performance.

The second assumption was that man and machine performance characteristics could be arrayed on a continuum, with uniquely human performance at one extreme and uniquely machine performance at the other. Description of a task in terms of the type of performance required allowed the task to be placed at some position along this continuum. Since this position could be described quantitatively, tasks could be compared to each other to determine their relative automatability.

Note that the intent was to obtain an index of relative not absolute automatability. There was no attempt to ascertain that such and such tasks should or must be assigned to machines. Rather, the intent was to determine the order in which tasks should be considered for automation, i.e., to obtain a numerical index of automation priority.

The Stevens ratio scaling technique was adopted because it is conceptually simple and relatively easy for individual raters to follow as a decision rule. Also, because the technique permits each case (i.e., task) to be compared with each of the others, the possibility of ambiguous or equivocal outcomes is greatly reduced. In its classic application, ratio scaling is used to obtain a relationship between the physical and psychological dimensions of a series of events (e.g., intensity of hues or loudness of sound). Obviously, man-machine task allocation is not such a case because there is no overt, physical dimension of the task with which to correlate subjective magnitude estimates. However, the later work by Stevens in the area of purely judgmental ratings, of which the passage cited earlier is typical, demonstrated the validity of subjective ratings for which there are no physical coordinates at all (e.g., the "esthetic attractiveness" of hues or "annoyance" of sound). Thus, the selection of the Stevens method was predicated upon the hypothesis that individual judges had (or could, with appropriate instructions, acquire) an internal scale of values relating to task performance requirements. Further, it was hypothesized that such a scale could be used by raters as a yardstick to produce reliable quantitative judgments about the amenability of tasks to performance by human or machine resources.

Man-machine task allocation is a complex judgment, involving an interplay of several factors. Rather than ask the raters to combine all these factors in a single, global judgment, it was decided to construct multiple rating scales which, by statistical manipulation, could be aggregated to form a unidimensional automation index. This procedure offered several advantages. First, it facilitated more precise discriminations by the raters by allowing them to concentrate on one aspect of the task at a time. Second, it promoted greater factorial purity among the constituents of the automation index; variations of raters (either individually or collectively) across rating dimensions could be more easily isolated and analyzed.

Another important reason for using multiple scales was that rater bias could thus be minimized. The question of automation, particularly as it relates to air traffic control, is controversial. Consequently, it did not seem advisable to ask raters to score tasks directly as to their automatability because this would elicit (and perhaps reinforce) whatever bias the raters might have. Ratings of greater objectivity could be obtained by disassembling the raters' decision into a series of separate component judgments.

A final reason for preferring multiple-scale ratings related to the subject of the ratings themselves, i.e., man-machine performance capabilities.

It was asserted earlier in this chapter that the concept of man vs. machine is misleading. It is overly simplistic to perceive task allocation as some sort of competition between humans and automata. A more accurate view is to think in terms of performance capabilities which are shared to some degree by man and machine but which may be manifested in different ways. Thus, by seeking rater judgments on a series of particulate aspects of the task and by casting the question in terms of the type of performance required (rather than the type of resource to be assigned), it was believed that more pertinent and valid judgments could be obtained.

The particulars of the methodology and the procedures by which ratings were obtained and analyzed are described in Chapter 3. The results of the ratings, man-machine task allocations, and the grouping of tasks in recommended levels of automation are presented in detail in Chapter 4 and in summary form in the following section.

2.5 SUMMARY OF RESULTS

The AATMS function and task analysis proved to be an effective device to describe air traffic control activities generically for the purpose of man-machine allocation. The use of task performance capabilities as the basis for rater judgments, which were expressed by the Stevens ratio scaling method, resulted in a quantitative data pool that could be manipulated mathematically to produce a ranking of tasks according to their relative automatability. This ranking, designated as the Automation Index (AI) was both highly discriminative and statistically reliable, i.e., the 265 tasks were ordered into 176 discrete ranks and the intercorrelation of rater judgments had a reliability coefficient of 0.822.

As an external check on the validity of the ranking by Automation Index, the relative placement of tasks was compared with the state of automation of equivalent tasks in the present-day air traffic control system. Very close agreement was found. Of the 22 generic tasks which could be unequivocally associated with tasks in the present system and which are automated now, 20 were also adjudged suitable for automation according to the Automation Index.

The array of tasks ranked by Automation Index was subdivided, on statistical grounds, into five incremental levels of system automation. Examination of the tasks grouped at each automation level revealed that there were common characteristics which could be used to describe the progressive automation of the system. These shared characteristics showed both an internal consistency within levels and a logical relationship between levels, lending further credence to the validity of methodology of ranking tasks by Automation Index. The following is a summary of the five incremental levels of automation which resulted.

> <u>Level I - Automation of Computational Aids</u>
>
> Tasks allocated to machines at the lowest order of automation are those involving repetitive computation and routine data processing, primarily in the areas of active control of aircraft (surveillance and vectoring) and maintenance of the system data base.

Level II - Automation of Aids to Decision Making

Automated resources are assigned to tasks such as detection of flight plan deviations and conflicts and formulation of possible solutions. Machines are also assigned to more sophisticated data processing tasks. Thus, the machine begins to function as a means of alerting man to the need for a decision and of providing him with data to assist his decision making.

Level III - Automation of Decision Making

At this level many decision-making tasks, particularly those of a routine and repetitive nature, are assigned to machines. Level III is also characterized by essentially complete automation of records keeping and maintenance of the operational data base.

Level IV - Automation of Communications

At level IV the machine replaces man in air-ground communication loop for routine relay of information, e.g., vectors, clearances, and flight advisories. Man is still assigned responsibility for communication of a special or emergency nature. Thus, the system passes from voice communication to two-way data link for normal modes of operation. At this level, virtually all strategic planning and regulation of traffic flow is also delegated to automated resources.

Level V - Full Automation

This level represents a hypothetical system in which man has no direct responsibility for regulation and control of air traffic. All planning, all surveillance, all intervention, and all communication have been automated. Man's role has become that of a system monitor and manager. Thus, man does not control aircraft; he controls a complex of automated resources which, in turn, controls aircraft.

3.0 METHODOLOGY

3.1 TASK DESCRIPTIONS

During the initial phases of the study, an extensive analysis was made of air traffic control functions. This analysis, which was performed at three successive levels of detail, resulted in the identification and description of a total of 265 tasks, grouped into 17 basic ATC functions. The task analysis and an account of how it was performed are presented in Volume II of this report.

The major items of information which make up the task descriptions are:

- Task title
- Identification of the parent subfunction and function
- Description of the purpose and circumstances of task performance
- Task information inputs and origins
- Task information outputs and destinations
- Decisions and actions (subprocesses of the task)

This compilation constituted the data base from which man-machine performance requirements for each task were to be identified and classified.

An important feature of the task analysis is its generic nature. Functions, subfunctions, and tasks are described in terms which were not specific to the present ATC system or to future system concepts, and there is no predisposition toward any particular form of implementation. For the purposes of task allocation, this generic approach to system description was absolutely essential to assure that assignments to man or machine resources should be both unbiased by present system design and unencumbered by equipment constraints.

3.2 PERFORMANCE CAPABILITIES

At the outset of the study a review was made of the research literature on man-machine performance capabilities. The result of this survey was a list of approximately 200 citations, grouped under seven basic categories of performance. (See Appendix A.) This pool of information was used to construct generalized scales of performance characteristics for evaluating man-machine task assignments.

The use of performance characteristics of man and machine as scalar dimensions for task allocation was suggested, in part, by the findings of the literature review. Several of the source documents described man-machine performance in a series of comparative statements, such as "man is flexible and adaptable; the machine is fixed and deterministic," or "the machine is a quantitative processor; man is a qualitative assessor." While antithetical statements such as these serve to clarify the distinctions between man and machines, they tend to overlook the fact that men and machines share some performance attributes and that there are subtle shades in this overlap. Pursuing this line of reasoning one step further leads to the conclusion that the performance descriptions found in the literature should not be considered as dichotomous, either-or propositions but as evidence that performance capability is a continuum with man-like characteristics at one pole and machine-like characteristics at the other. If so, then it is possible to construct a series of dimensions, each describing some aspect of man-machine performance, and to express the performance required in any given circumstance as some proportion of man and machine qualities.

The development of these scaling dimensions was a three-step process. First was the selection of the dimensions to be used. Despite differences in terminology, the literature suggests that man and machine performance capabilities can be grouped in seven major categories:

- Monitoring
- Sensing
- Information Processing

- Interpreting
- Decision Making
- Storing and Retrieving Information
- Responding

While these categories are not mutually exclusive in any absolute sense, there is sufficient agreement among the source documents reviewed to conclude that they do represent distinctly different types of performance capability.

Therefore, the first step was to analyze each of these performance categories to see if they were relevant to air traffic control tasks. It was concluded that all types of performance were involved to some degree, but that responding should be excluded on the grounds that it was means-oriented. Response capability tends to be highly system-specific. That is, the type of response required to carry out tasks and the method by which response is made are determined by system mechanization and equipment characteristics. In one ATC system the response required for a given task might be to make a written entry; in another it might be to operate a keyboard or to speak into a voice relay; in still another the appropriate response might be to transfer data from buffer to storage. Since the study was intended to be concept-free and hardware-independent and since the task descriptions to be used in man-machine allocation were generic, there seemed to be no reasonable basis for judging just what the response requirements might be. For these reasons, it was decided to limit the task performance dimensions to the first six listed above.

The next step was to consolidate the various assertions found in the literature into a rather small number of essential propositions about the characteristics of man and machine performance in each of the six capability categories. Condensation was necessary for two reasons - first, to eliminate redundancy among the source documents; second, to limit the number of criterion statements to manageable proportions. Thus, each performance dimension was reduced to a series of axioms, such as "machines excel at monitoring which requires continuous attention or detection of random, infrequent events; in the same situation man is easily distracted and unreliable."

Note that the differentiation between man and machine was not made among performance dimensions but within each dimension. Thus, there was no assertion that man or machine is superior in any performance capability. Quite the contrary, the fundamental proposition was that both man and machine have all of the six performance capabilities. However, when man or machine exercises any given capability, the performance has such and such characteristics.

The final step was to simplify the axioms even further by reducing them to unipolar statements. Thus, where the statement had been "Machines have such and such characteristics, and men have the opposite," it was abbreviated to "Machines have such and such characteristics." The result was to compress all of the man-machine characteristics within each performance dimension into a single continuum, with one end point defined explicitly and the other inferentially. Table 3.2-1 is a complete listing of the six performance dimensions, with definitions, examples, and characterizations of resource characteristics.

Note that in Table 3.2-1 the machine end of the performance scale is not explicitly identified as such. It is simply called "Required Resource Characteristics." This was done to suppress any bias which the judges might have about automation or about assigning any particular type of task to men or machines. The disguise is very thin, and even the briefest reflection about the meaning of the required resource characteristics would reveal that the type of resource called for is a machine. However, it was felt advisable not to direct undue attention to the question of automated resources so that the judges would be encouraged to base their decisions about task allocation on the type of capability required not the source of that capability.

Note also that all the resource characteristics are positive attributes. Each statement identifies a type of task performance that machines do well. Negative aspects of machine performance (and positive aspects of human performance) lie at the opposite end of the scale and are identified only by inference. Thus, the decision to assign a task to a machine would be based on positive reasons, i.e., the type of performance called for by the task is a property which machines have. This represents a cautious

Table 3.2-1 Classification of Performance Capabilities

MONITORING

To maintain a state of readiness or preparation for receipt of inputs

Examples	Required Resource Characteristics
Search	Monitoring of infrequent events
Surveillance	High reliability in detecting signals
Vigilance	Monitoring specific physical energies
Watch-keeping	Continuous attention
	Monitoring scheduled or predictable events
	Monitoring of long-duration events

SENSING

To perceive external stimuli, to recognize a change of external state, to acquire data from the environment

Examples	Required Resource Characteristics
Perception	Sensing specific physical energeies
Signal Detection	Sensing the same stimulus frequently
Signal Recognition	Sensing several similar stimuli simultaneously
Discrimination	Simultaneous multichannel sensing
Recognition of Discrete Change	Sensing quantitative values
Recognition of Dynamic Change	High sensitivity
	Sensing over long distances

INFORMATION PROCESSING

To transform, to organize, to break down, to combine, to operate on input data or signals

Examples	Required Resource Characteristics
Encoding/Decoding	Numerical computation
Sorting	High volume and/or speed of transactions
Filtering	Simple processing rules or specific programs

Table 3.2-1 Classification of Performance Capabilities (Cont'd.)

INFORMATION PROCESSING (Cont'd.)

Examples	Required Resource Characteristics
Ordering	Parallel or multichannel operations
Merging	Repetitive operations
Analysis	High accuracy or precision
Computation	

INTERPRETING

To construe, to derive, to translate, to assign meaning to data or signals

Examples	Required Resource Characteristics
Pattern Recognition	Assigning items to a large inclusive class by specific rules
Interpolation	Assigning a narrow range of meanings to inputs
Extrapolation	Estimation of rate of change, acceleration, or higher order derivatives
Prediction	Consideration of specific, predictable or unambiguous inputs
Association	A minimum number of errors due to expectation or cognitive set
Classification	

DECISION MAKING

To select among alternatives, to determine a course of action, to assess the validity of a proposition

Examples	Required Resource Characteristics
Hypothesis Formulation	Dependence upon complex procedures or operations
Induction/Inference	A large number of differentiations or integraiions
Deduction	Deductive reasoning without reference to context
Probability/Contingency Estimation	Prediction based on variables whose nature and weightings are known in advance
Identification and Comparison of Alternatives	Selection among well defined alternatives
Comparison with Standards or Criteria	Invariant decision-making logic
Selection/choice	Short time lags between scheduled events

Table 3.2-1 Classification of Performance Capabilities (Cont'd)

STORING AND RETRIEVING INFORMATION

To retain or to remain aware of information and, conversely, to recall or to bring forth previously acquired information

Examples	Required Resource Characteristics
Short-term Memory	Long-term storage with total recall
Long-term Memory	Rapid storage (ingestion) of large amounts of data
Total Retrieval/Recall	Infallible memory with the precise source of data accurately tagged
Selective Retrieval/Recall	High speed and/or frequent memory search
Purging	Short-term storage and retrieval of large amounts of data
	Multichannel storage or retrieval
	Large buffer (immediate memory) capacity
	Storing of coded or numerical data
	Rapid and/or complete purging (erasure) of stored data

approach to automation in that the construction of the scale encourages raters to allocate to machines only those tasks for which machines are well suited.

It could be argued that reduction of the complex question of man-machine performance capability to a series of rather brief axioms is a vast oversimplification. Perhaps so, but bear in mind that the purpose of the undertaking was to develop scaling dimensions for use as criteria in man-machine task allocation. The intent was not to force a mechanistic decision on the judges but to guide their thinking along certain lines so as to elicit a quantitative expression of the relative ability of men and machines to perform air traffic control tasks. Viewed in this way the numbers of criteria is considerably larger than usual. Each task is ratable upon six dimensions, and within each dimension there are between five and nine aspects of performance to be considered. Taken together, this gave the rater forty potential factors to take into account.

3.3 MAN-MACHINE PERFORMANCE RATING

The task descriptions and the performance capability scales constituted the essential elements for man-machine allocation. Arraying these ingredients in a two-dimensional matrix, where one dimension was composed of 265 tasks and the other of six performance capabilities, provided 1590 cells. Theoretically, each cell was a possible decision point for task allocation. In fact, however, the number of operative cells was considerably smaller since not all performance capabilities were relevant for all tasks.

The procedure for elimination of the irrelevant task-capability conjunctions was to submit the question to a panel of five experienced human factors specialists. Each made an independent review of all tasks against the six performance capabilities and presented his judgment of the relevant combinations. Comparison of the five sets of judgments indicated that for 1208 of the 1590 cells in the task-capability matrix (about 76%) there was consensus, which was defined as agreement of at least four judges that a given performance capability was or was not relevant to the task. This left 382 cases where there was a split 3-2 vote for or against. In the interest of preserving as many data points as possible, it was decided to retain all but those cells where four or five of the judges agreed that the performance capability was not relevant to the task. In other words, if at least two judges thought that a given performance capability was relevant to the task, the cell was retained for man-machine allocation rating. Table 3.3-1 is a summary of the judges' votes and the disposition made.

Table 3.3-1 Summary of Judgments on Relevance of Performance Capabilities to Tasks

	Number of Votes for Relevance					
	5	4	3	2	1	0
Number of Cases	258	130	207	175	273	547
Percentage	16.2	8.2	13.0	11.0	17.2	34.4
Disposition	Retained for Rating				Deleted	

Deletion of the irrelevant cells left a 265 x 6 matrix with a total of 770 task-capability conjunctions for which man-machine allocation ratings were to be made. Appendix B of this report is a tabulation of the relevant performance capabilities by task.

With this preliminary step completed, it was then possible to proceed with the task ratings themselves. As discussed in Section 3.2 above, performance capability scales had been constructed, with machine-like characteristics arrayed at one end and man-like characteristics at the other. (It will be recalled, however, that only the machine end of the scales had been explicitly defined.) These scales represented six basic dimensions of task performance. The resource characteristics defined for each scale were criterion reference items against which to evaluate tasks for allocation to men or machines. The method for making this evaluation was the Stevens ratio-scaling technique.

The procedure for making man-machine performance ratings involved the following steps for each task.

1. The rater examined the task description to familiarize himself with the functional details.
2. The rater consulted the task-capability matrix which designated the basic capabilities required to perform the task.
3. For each capability relevant to the task, the rater reviewed the criterion statements of resource characteristics. (See Table 3.2-1, Page 3.2-4)
4. The rater made a comparison between the criterion statements and his own estimate of the performance characteristics required for the task.
5. The rater expressed the comparison as a number, whose magnitude indicated the degree of correspondence between the criterion statements and his own estimate of the required performance characteristics.
6. The rater repeated steps 3, 4, and 5 until the task had been rated on all the relevant performance dimensions.

An example may help to clarify the process by which the rater arrived at a judgment. Suppose that for a given task the required performance capabilities were monitoring, sensing, and information processing. Referring to Table 3.2-1, the rater would find statements characterizing a resource with each of these capabilities. If the rater felt that the task called for monitoring of infrequent events and continuous attention, he would assign a high number to the monitoring dimension because these are two of the resource attributes listed in the table. If in the case of sensing, however, he determined that none of the attributes listed were appropriate for the task, he would assign a low number for this dimension. If the information processing portion of the task involved numerical computation but the operation was not repetitive and did not require high precision, an intermediate number would be assigned because some of the attributes listed in the table were appropriate and some were not. In each case, the numbers assigned by the rater was a proportionate estimate of the match between what he considered to be the resource attributes required for the task and those of the criterion statements in the performance scale defined in Table 3.2-1.

Note that the rater was not obliged to use any prescribed number of increments nor any fixed size of interval within a scale. Neither was it necessary that he use increments of equal size throughout the scale. The essence of the Stevens method is that the rater be left free to choose scale values which suit his own perception of the continuum. If the rater believed he could make very fine discriminations either throughout the scale or in some portion of it, the technique allowed him to do so. Likewise, if the rater perceived a great difference between two cases, he could select a ratio as large as he liked. For example, if a rater used the numbers 2, 4, and 47 to describe his estimates of three positions along a continuum, he would be saying in effect that the first was only about half as great as the second but that there was only a slight difference between them in comparison with the third, which differed by an order of magnitude. This feature permits judgments of great subtlety and precision, and it is for this reason that the Stevens method is sometimes called free number matching.

The rating procedure had the effect of reducing the question of man-machine task allocation to a series of particulate, quantified judgments about performance capabilities in relation to functional requirements. The rater was not expected to make a global decision about the level of automation in the system. In fact, he was not expected to make any explicit judgment at all about automation. Instead, he was asked to characterize, task by task along each performance dimension, the type of appropriate resource to be assigned without ever specifically identifying that resource as a man or a machine. By atomizing the task allocation process in this way and by reducing it to a systematic procedure, rater bias and the intrusion of extraneous factors were minimized.

Obtaining the judgments in numerical form served several important purposes. First, it tended to promote objectivity. It also helped to minimize ambiguous judgments. Even more important, all judgments were cast in a common form, which allowed mathematical manipulation and aggregation of estimates within and across raters in order to integrate the individual data points into a comprehensive man-machine allocation scheme.

As a final step before starting the rating procedure, the methodology was subjected to a pre-test. A group of five raters was selected and asked to make ratings on a sample of tasks comprising four of the seventeen generic ATC functions. A brief statistical analysis was made of the same ratings to ascertain whether the technique would produce the expected results. The pre-test showed that the procedure was workable and that the ratings did, in fact, discriminate among tasks along the relevant performance dimensions. The pre-test also suggested some minor modifications of the rating procedure.

The most significant finding was that, despite instructions to the contrary, raters were inclined to use a very narrow numerical scale with only a few increments. Most probably this was attributable to previous exposure to the traditional three-, five-, and seven-point scales where the splitting of scale intervals is discouraged. To overcome this tendency and to encourage the proper application of the Stevens method, it was decided to specify that the raters use a scale of 1 to 99 and that they discriminate among similar cases if at all possible. While this would place a limit on scale values, in that the rater would no longer be free to choose any number to express his estimate, the 1-99 range was felt to be large enough not to impose any practical constraint on rater choice. (For a further discussion of this point in connection with the actual ratings obtained, see Subsection 3.5.1.)

The pre-test also indicated that in a few cases raters disagreed with the designation of the performance capabilities relevant to the task. Most often, they took a more restricted view of required capabilities than the panel of five judges who had made the original designations. This was not wholly unexpected since the task-capability matrix compiled from the judges' opinions was somewhat overinclusive in that it had left out only those capabilities which had received one or no votes as to their relevance to the task. To allow the raters as wide a latitude of judgment as possible, it was decided to allow them to decline to rate any performance capability they thought irrelevant to the task and, conversely, to include ratings for any task-capability cells which the panel of judges had deleted.

Originally, it had been planned to obtain ratings on all 265 tasks at one time. However, the pre-test showed that such an exercise would be too arduous. Rating all the tasks was estimated to require from three to four days of work, which would introduce the danger of serial position bias if accomplished in one continuous session. For this reason, it was decided to conduct the rating exercise in two sessions, separated by two or three weeks. In the first session, ratings were planned for eight functions, containing a total of 115 tasks. Ratings for the remaining functions (150 tasks) were scheduled for the second session.

3.4 DATA COLLECTION

A group of thirty-two persons, drawn from contractor personnel and representatives from DOT/TSC and FAA/NAFEC, was selected to perform the task allocation ratings. The grounds for selection were that the participant had to have experience in systems engineering, human factors, computer applications, or air traffic control. Contractor personnel who took part in the pre-test and those who had developed the rating instruments were excluded from the pool of raters to avoid contamination of the results. While the group of raters was not a stratified sample, it did include representatives from all the disciplines and occupations considered to have a contribution to make to the question of automation in air traffic control. Table 3.4-1 is a summary of the basic specialties and organizational affiliations of the raters.

Table 3.4-1 Rater Specialties and Organizational Affiliation

Specialty[1]	Affiliation		
	Contractor[2]	DOT/TSC	FAA/NAFEC
Systems Engineering	4	5	-
Human Factors	5	1	5
Air Traffic Control	-	-	12
Computer Applications	3	4	4
Total Participants	9	6	17

[1] The columns are not additive since some raters had more than one specialty.

[2] Contractor personnel included representatives from TRW, The Planar Corporation, and Stanford Research Institute.

A more detailed analysis of the raters' background and experience is presented in Table 3.4-2. Note that several raters had experience in more than one of the basic specialties and that nearly all had taken part either in the design of advanced man-machine systems or in ATC experimental studies. Note also that seven raters had flying experience in either military, air carriers, or general aviation.

Table 3.4-2 Analysis of Rater Background and Experience

RATER	SPECIALTY	OPERATIONAL ATC EXPERIENCE					DESIGN/DEVELOPMENT ADVANCED MAN-MACHINE SYSTEMS	ATC EXPERIMENTAL STUDIES	FLYING EXPERIENCE			COMPUTER APPLICATIONS
		TERMINAL	ENROUTE	FSS	NAFEC	MILITARY			MILITARY	AIR CARRIER	GENERAL AVIATION	
1	Systems						√					√
2	HF						√					
3	HF						√					√
4	HF	√	√	√		√			√	√	√	
5	HF					√	√		√			
6	HF						√					
7	Systems						√					√
8	Systems									√		√
* 9	HF						√					
10	Systems						√	√				√
11	Systems							√				
12	Systems							√				√
13	HF							√			√	√
* 14	ATC	√	√	√	√	√		√			√	
15	ATC		√		√			√				
16	ATC	√	√		√			√				
17	HF						√	√				
18	ATC	√			√	√	√	√				√
19	ATC	√			√		√	√	√			√
20	ATC		√		√	√		√				
21	ATC		√		√	√		√				
22	ATC	√	√	√	√		√	√				
23	ATC	√			√	√	√	√				
24	ATC	√	√	√	√	√	√	√				
25	HF						√	√				
* 26	HF						√					√
27	ATC	√	√	√	√	√	√	√				
28	HF						√	√				
29	ATC	√	√		√	√	√	√				
* 30	Systems							√				
31	Systems						√		√		√	
* 32	Systems							√				√

* Deleted from the final sample because only partial ratings obtained

Of the thirty-two raters originally selected, five were unable to complete the rating exercise. They participated in the first rating session but, because of other assignments or illness, could not take part in the second. These raters are identified in Table 3.4-2 by an asterisk beside the rater identification number. To avoid complication in the data analysis and interpretation, the five partial sets of ratings were discarded, leaving a final sample size of twenty-seven raters.

Ratings were obtained in two sessions for each organization group (contractor, DOT/TSC, FAA/NAFEC), making a total of six separate administrations. Each session consumed between eight and twelve hours over a two-day period. The reference materials used by the raters consisted of:

- Detailed task descriptions (similar to those presented in Volume II of this report)
- Schematic system flow diagrams
- Performance capability descriptions (See Table 3.2-1)
- A task-capability matrix, with spaces provided for recording the ratings (See Appendix B).

Although assembled as a group for ease of administration, the raters worked independently and did not consult each other for interpretations or assignment of ratings.

A tabulation of the individual ratings for all tasks is presented in Appendix C of this report.

3.5 DATA ANALYSIS

The man-machine performance ratings constituted a data base with three dimensions: tasks, performance capabilities, and raters. Arraying the data orthogonally along these dimensions produced a matrix with 42,930 cells (265 tasks x 6 performance capabilities x 27 raters). However, about half of the cells were empty because not all the task-capability conjunctions were relevant and so had not been assigned ratings. Deleting the empty cells left a matrix with approximately 21,000 data points (770 task-capability conjunctions x 27 raters).

The objective of the data analysis was to derive a single ordinal scale of the automatability of air traffic control tasks. In effect, this involved collapsing the matrix from three dimensions to one by aggregating the data across raters and performance capabilities to obtain a measure designated as the "automation index." The index would order ATC tasks according to their relative automatability, i.e., the order in which they were to be considered for transfer from manual to automated resources in AATMS. The desired properties of the automation index were that it produce maximum discriminability among tasks and that it provide a stable (i.e., reliable) indication of the rank position of each task.

Treatment of the data to develop the index of automation involved several major concerns. First there was the general psychometric question of scaling the raters' responses. A related concern was the matter of aggregation, both among raters and across performance dimensions. Another question was that of dealing with idiosyncratic rater responses. It was also necessary to examine the data to determine the influence of rater reliability (both intrarater and interrater) and of group effects related to rater experience and occupational specialty. Finally, there was the need to examine the overall question of the level of confidence which could be attached to the automation index itself. These topics are discussed below in subsections 3.5.1 through 3.5.5. The automation index and its application to determining levels of automation are presented in Chapter 4.

3.5.1 Scaling

For reasons presented in Section 3.3, the raters had been instructed to use a rating scale whose range was 1 to 99. Since the final ranking of tasks would require a grouping into only about four or five levels, the original scores had a sizeable built-in compression ratio. In effect, the situation had been contrived so as to provide the rater with an opportunity to impose a very high degree of precision in judgment if he was so disposed. Since there was no intent to use the raw ratings in any absolute characterization of the automatability of tasks (or in any algebraic computation), the nominal precision of the raw scale range was only a concession to the self-regard of the raters for purposes of enhancing their cooperation.

In fact, most raters transformed the 1-99 range to a 20 point scale by using scores divisible by 5. From a sample of scores assigned by each of 27 raters, 11 raters (about 41%) used numbers other than multiples of 5. (The expected value would, of course, be 80%.) Given this tendency on the part of the raters and in the absence of a requirement for high ranking precision, it was decided to consider the prospect of simplification to a 20-point scale.

The first analytical step was to characterize the distribution function of the ratings by the individual raters. Graphic plots were made of rater scores. Figure 3.5-1 provides examples of the raw score frequency distributions of three raters on a 20-interval scale. The distribution of raw scores for all raters is given in Appendix D.

Certain response tendencies are apparent in the graphs. Rater 1, for example, has a clear tendency to operate with a ten-point scale. The overall distribution is skewed to the low side. Rater 11 shows the same tendency to avoid scores ending in the numeral 5. In his case the distribution is slightly skewed to the left, bi-modal, and inverted. (We shall have occasion to return to Rater 11 in the following section as an example of the effects of various transformations.) Rater 12 presents a distribution rather markedly skewed to the high end. However, here the distribution is uni-modal and without a pronounced numeral selection tendency.

An examination of the raw scores of other raters confirmed that, with the exception of the tendency to prefer certain numbers, no uniform pattern

Task Ratings on Functions 2, 3, 4, 5, 6, 7, 8, 9, 13

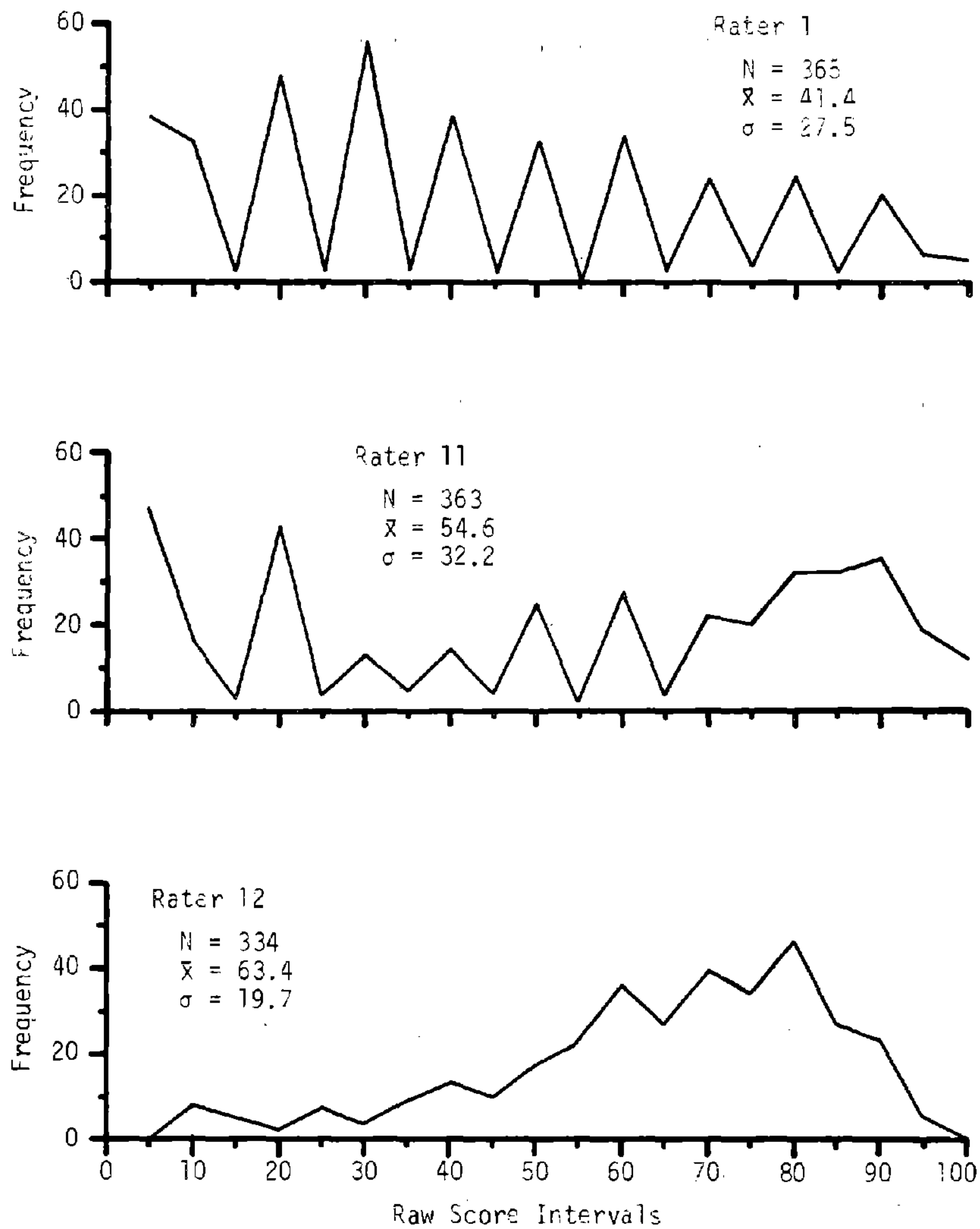

Figure 3.5-1 Twenty-Interval Raw Score Distribution for a Sample of Three Raters

of modality or skewness was present. Additional evidence on this matter is presented in capsule form in Table 3.5-1 which contains the raw score mean and standard deviation for all raters. The average standard deviation is 23.6. The difference between the highest and lowest means is 51.8 points, which is very high. One would conclude that there were strong individual-differences effects. However, it is also clear that the problem of heterogeneity of variance does not arise in this set of data.

The picture provided by the distributional analyses led to the tentative conclusion that there might be a problem of individual magnitude preference. In other words, some raters appeared to prefer high numbers, others low numbers, others both high and low but not middle value numbers, and so forth. Since the ratings were based on highly particularistic associations, it was possible to retain the working hypothesis that these tendencies did not necessarily reflect a prejudice in task allocation to either man or machine but that the phenomenon was simply an artifact of the procedure.

The accepted general method for resolving such anomolies is by normalization and standardization of the raw scores (Chronback, 1960, p. 83 ff). Several options were available. The first tried was within-rater normalization (z-score transformation) and standardization to a nine-point scale (i.e., a stanine transformation to avoid negative decimal fractions and to compress the data).

An example of the transformation to normalized standard scores for Rater 11 is presented in Figure 3.5-2. Several characteristics can be noted. First, the gross bi-modality in the raw score distribution has been substantially muted but not completely eliminated. However, the precision or discriminative power of the scores has clearly been impaired because of the complete elimination of extreme scores. (Score intervals 1, 8 and 9 are empty.)

Other tests were made of the discriminative power of the z-stanine transformed scores by a check of the transformed scores against instances of extreme raw scores. For example, Rater 1 had 38 scores in the 1-5 range. In each case, the stanine score was 3. Rater 1 also had 11 scores between 95-99, which converted to a stanine score of 8. When the analysis was enlarged to cover a sample of ten raters, the effect was somewhat less

Table 3.5-1 Analysis of Raw Score Distribution for all Raters

Rater	Number of Ratings	Mean	Standard Deviation
1	770	55.6	31.0
2	768	57.2	27.7
3	730	50.3	32.3
4	710	68.5	28.8
5	648	55.6	30.6
6	767	78.2	19.3
7	770	74.9	18.2
8	770	63.4	28.2
9	764	64.8	23.7
10	770	60.2	28.4
11	770	60.5	20.8
12	770	33.6	22.1
13	770	74.8	18.4
14	770	75.6	19.9
15	765	36.7	16.2
16	769	39.2	19.6
17	770	70.7	21.4
18	768	52.6	24.2
19	770	76.1	27.2
20	770	66.8	19.7
21	770	85.4	19.4
22	770	51.1	27.1
23	770	36.1	22.2
24	770	75.5	21.1
25	770	59.1	28.7
26	761	75.8	22.9
27	501	43.9	23.9

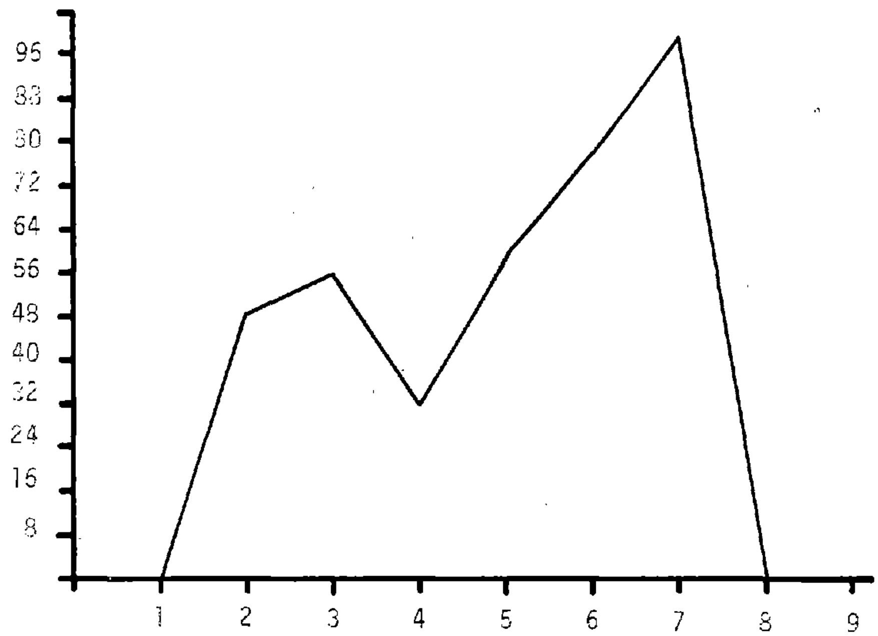

Figure 3.5-2 Normalized Standard Score Distribution For Rater 11

pronounced but more easily tested. Thus, the total number of ratings for all ten raters was 3529. For a distribution of this size, the normalization process should yield 61 scores of 1 and 61 scores of 9. The actual frequency of scores of 1 was 60, but the frequency of scores of 9 was only 14. This revealed an artifact of the normalization; those raters whose raw scores clustered on the high end of the scale generated transformed scores on the low end of the scale. In other words, the thrust of the original ratings was to some degree reversed by the normalization.

The data were examined in an attempt to counter these problems while retaining the benefits of normalization-standardization. The analysis revealed that each rater had distinct scoring patterns for each performance capability. That is, their scores were consistently high for one capability and low for another. The question then arose as to whether these variations between capabilities were consistent across raters. Table 3.5-2 shows there was a mixture of effects. There was a general tendency to rate interpreting low on the scale. The rankings of the other capabilities appeared to be more evenly distributed; but when the correlation of rank order and capabilities across raters was tested by the Spearman r Method, a value of 0.70 was obtained, which indicated substantial agreement among raters. While not clearly a population stereotype, this effect constituted a response bias that could be ameliorated, thereby allowing retention of the standard score treatment.

The scaling treatment suggested by this analysis was to normalize within each capability for each rater. The resulting z-score could then be standardized and used as such, or it could form the base score for some other type of aggregation.

3.5.2 Aggregation

Any form of algebraic manipulation or transformation of scores instigates the phenomena of regression toward the mean, which represents a potential loss of discriminability. On the other hand, transformation has the advantage of increasing the stability of scores. Thus, the problem could be stated as how to minimize loss of variability (constituting loss in discriminability) while attempting to adduce a summary index for each task by aggregating scores across capabilities and across raters. The

Table 3.5-2 Raw-Score Averages for Each Capability

Capability

Rater	Monitoring	Sensing	Information Processing	Interpreting	Decision Making	Storing/ Retrieving
1	57.8	52.1	59.4	50.8	52.4	59.6
2	42.4	48.6	59.9	47.0	70.4	55.5
3	51.0	49.3	49.2	45.0	56.2	51.7
4	71.8	74.6	65.0	58.2	79.7	69.6
5	67.0	61.7	60.9	51.0	54.3	50.0
6	84.1	68.5	75.1	77.6	84.0	78.3
7	66.2	68.2	67.4	78.9	79.8	80.1
8	63.5	63.2	63.4	53.7	64.7	74.1
9	83.6	72.2	66.3	60.6	56.1	71.0
10	66.6	73.1	59.4	42.4	72.2	64.2
11	66.8	54.6	47.0	64.2	65.4	72.4
12	43.1	40.5	30.4	30.2	34.9	36.9
13	75.5	74.3	74.8	75.3	76.7	72.1
14	75.1	77.3	76.6	77.6	75.2	71.8
15	25.0	26.3	45.2	29.8	40.1	32.6
16	36.8	42.0	41.6	40.4	37.9	35.3
17	71.1	56.7	75.5	69.6	77.6	59.8
18	64.8	63.6	51.8	48.6	56.1	48.4
19	83.1	81.7	77.9	72.2	74.2	77.0
20	67.2	64.3	69.1	65.5	65.2	67.2
21	86.4	80.3	85.2	84.2	86.0	87.6
22	46.3	52.3	52.0	50.2	46.6	56.8
23	19.1	23.9	32.3	22.8	26.4	22.2
24	77.3	74.6	74.0	77.5	77.9	72.6
25	55.9	50.2	62.6	54.1	50.2	73.6
26	74.4	81.2	76.5	75.2	70.1	81.4
27	40.6	36.5	46.1	41.3	42.2	47.9

ancillary problem was how to retain an indicator of the amount of variability between capabilities and between raters that would otherwise disappear by aggregation. The major complication associated with this ancillary question arose from the fact that different tasks were rated on different capabilities and on different numbers of capabilities (i.e., some capabilities were not relevant to some tasks). It will be recalled that six capability designations were used. Of the 265 tasks rated, two were rated on all six capabilities, 17 were rated on five capabilities, 73 were rated on four capabilities, 84 were rated on three capabilities, 40 were rated on two capabilities, and 49 were rated on only one capability.

Confronted with the need to make a trade-off between discriminability and stability, the approach was to seek a method which would allow both objectives to be at least partially met. Three basic choices were available. The first was aggregation on the basis of raw scores. This would have the advantage of retaining all the discriminability inherent in the scores. However, because of the distributional variations of individual rater's scores and the tendency to use different ranges for different performance capabilities, the stability of an aggregate based on raw-score was dubious. In effect, this would have meant a complete sacrifice of stability for discriminability -- clearly an undesirable choice. Nevertheless, it was decided to compute a raw-score aggregate anyway, primarily as a way of assessing the effects of the other two forms of aggregation.

The second choice was the method customarily employed by Stevens in his studies of magnitude estimates. The variability of magnitude estimations in cross-modality matching has been found to grow approximately in proportion to the physical magnitude of stimuli and to produce distributions that are roughly log normal. Consequently, the geometric mean of raw scores for each task would be an appropriate form of aggregation. This method of averaging would also have the advantage that, despite the different ranges of numbers used by different raters, no normalizing of scores would be needed prior to averaging. This was an acceptable and attractive option, and it was decided to employ the geometric mean as one type of aggregation.

The third possible method was transformation of raw scores to standard scores, with the arithmetic mean of the latter used as the aggregate index.

As noted in subsection 3.5.1 above, z-score transformation would have the effect of reducing the variability across capabilities for each conjunction of rater and task. It would also reduce the variability between tasks for each rater and the variability between raters.

Within this basic method there were several options as to the order in which the steps of averaging and transformation to a standard scale were to be taken. One possible technique was to aggregate z-scores across both capabilities and raters, to obtain the mean z-scores and, finally, to transform them to a standard 20-point scale. A disadvantage of this procedure was that the resultant summary score would have been a whole number, which would automatically create many ties between task rankings and great loss of discrimination in the middle range. The other undesirable effect of this procedure was that the index of variability within tasks (the standard deviation) would not be on the same scale as the summary score, i.e., it would be the standard deviation of the z-scores.

Other available techniques were: (1) average z-scores across capabilities, transform to a standard scale, and average standard scores across raters; (2) average z-scores by capability across raters, transform to a standard scale, and average the standard score across capabilities; or (3) transform directly to the standard scale and average across both capabilities and raters simultaneously. The last procedure appeared best for the following reasons. It would lead to a discriminate index which could legitimately be carried to two decimal places. It would yield a measure of variability that reflected variations across raters in the same scale as the task automation index itself. It would produce a second-order index of variability (in the form of the Standard Error of the Mean) which would compensate for the difference in the number of scores aggregated for each task.

To summarize, three forms of aggregation were selected. The geometric mean of raw scores by task and the arithmetic mean of standard scores by task were the two which offered the most promise. The arithmetic mean of raw scores, while unsatisfactory because of its instability, was also to be used, primarily as a check on the other two.

3.5.3 Idiosyncratic Response

While the instructions to the raters generally suggested a forced-choice form of response, the raters were offered the options of declining to rate some task-capability conjunctions or, conversely, to provide a rating where none was asked for. In a few cases, raters chose to avail themselves of one or both of these options. In doing so, the rater was imposing a weighting scheme on the scoring.

In all, 770 ratings were called for from each of the 27 raters, making a total of 20,790 expected responses. Of these, 550 were deleted by the raters*, and 130 were inserted on the raters' initiative. For the primary analysis, deletions were simply bypassed, and rater-initiated scores were not included. However, the information implicit in these actions on the part of the expert raters was not discarded. The utilization of this information took two forms. First, the independent actions of the raters were taken as possible symptoms of problems in the rating instrument. If any pattern of idiosyncratic response by raters was discernable from a particular task, it could be inferred that either the original assignment of relevant capabilities was erroneous or that the task description itself was faulty. In other words, deletions and rater-initiated responses were taken as quality control indicators and were used to flag troublesome data items. Second, the idiosyncratic responses were to be used as an ingredient in the index of confidence for each task rating. (See subsection 3.5.5 below.) It was anticipated that any serious errors in the rating instrument would be revealed by the confidence index. If task items were to show both deviant confidence index values and instances of rater initiative, there would be a clear case for isolating such tasks from the primary analysis.

The rater initiated responses were highly scattered among the 265 tasks. As a whole, additions amounted to less than 1% of the scores and deletions comprised less than 2%. Thus, the impact of these initiatives was nominal with respect to the automation index. The scattering of response was such that only 23 of the 265 tasks were modified in any way by more than two raters.

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* It should be noted that two raters contributed 395 of the 550 omissions. The remaining 25 raters deleted an average of 6.2 ratings from the set of 770 - or less than 1%. Nine of the raters made no modifications at all.

The tasks listed below are those with two or more rater-initiated deletions or insertions. The disposition of these items and an explanation of the probable reasons for idiosyncratic responses by raters are presented in Section 4.1 with the discussion of the automation index.

Table 3.5-3 Tasks With Rater-Initiated Deletions or Insertions

Task No.	Title
1.3.3	Transmit Requested Information Via Telephone
3.1.2	Specify Aircraft and Pilot Information
4.4.2	Cancel Flight Plan
6.1.4	Request Aircraft Identity
6.3.2	Compute Short-Range Extrapolations
7.1.4	Compare Intended Time-Position Profiles For Intersections in x, y, h, & t
7.1.5	Propose Revised Flight Plan to Correct Long-Term Conflicts Among Flight Plans
8.2.4	Transmit Performance Change Message to Pilot
9.1.1	Determine Identity and ETA of Arriving Aircraft
9.3.2	Allocate Blocks of Time for Arrivals and Departures
11.1.2	Determine Requirements for Further Vectoring
11.2.1	Measure Course and Distance
11.4.1	Compute Heading Command
11.4.2	Compute Airspeed Command
11.4.3	Compute Vertical Speed Command
12.1.5	Compile Special Response to Request
12.2.7	Correlate Present Position with Distribution Position
12.3.1	Determine Endangered Aircraft
13.1.3	Correlate Aircraft Position With Airspace Structure Boundaries
14.3.4	Retrieve Required Data
17.7.3	Retrieve Affected Data Base Item
17.8.3	Retrieve Affected Data Base Item
17.11.1	Determine Requirement for Preformatted Data Modules

3.5.4 Interrater Reliability and Group Effects

One of the possibilities that had to be considered was that instead of giving their true appraisal of each task, raters had responded to preconceptions arising from their experience or present work. In other words, it seemed possible that various group-affiliation effects could be the source of some consistent bias in the ratings. This possibility was checked by using rater background as the test variable in two analyses of variance.

In the first instance, raters were grouped by organizational affiliation. Three groups were compared: raters from DOT/TSC, from FAA/NAFEC, and from contractor organizations. The results of the analysis of variance are presented in Table 3.5-4.

Table 3.5-4 Analysis of Variance Due to Organizational Affiliation

Organization	No. Raters	Group Mean	F
DOT/TSC	5	64.8	
FAA/NAFEC	15	59.3	0.256
Contractor	7	58.5	

The raw score average of the five raters from DOT/TSC is the highest, 6.3 points higher than the lowest group, contractor personnel. However, all three averages are well within the boundaries of a common population as indicated by the F-ratio of 0.256. Given the number of groups and the number of raters in each group, an F-ratio of 19.45 or larger is required to reject, at the 5% confidence level, the hypothesis that the sample groups come from the same population.

In the second test, raters were grouped by their occupational specialty. Again, three groups were formed: ATC operations, computer applications, and human factors/systems engineering. The results are set forth in Table 3.5-5.

Table 3.5-5 Analysis of Variance Due to Occupational Specialty

Specialty	No. Raters	Group Mean	F
ATC Operations	12	67.7	
Computer Applications	6	58.8	3.453
Human Factors/Systems	9	50.8	

In this case, a slight trend is apparent in the raw score averages, but it is far from pronounced enough to be verified by the F-ratio ($F = 3.453$ whereas $F_{.05} = 19.45$). It is of some interest to note that raters from a background of computer applications are centered between the two other groups in a situation where those with computer experience might be expected to show a bias toward higher scores, i.e., toward more automation.

In brief, the two analyses revealed no basis for concern that the raters showed prejudicial tendencies in any consistent way in their assignment of task ratings.

A second, and much more troublesome, possibility was that the raters were entirely idiosyncratic in their responses. If such were the case, the validity of the whole rating procedure would be in doubt. The standard test for such a condition is the statistic of interrater reliability, which tests the correlation among raters on an item-by-item (task-by-task) basis. It is somewhat rare to have a body of data involving such a large number of raters. Most reliability tests are predicated on a comparison of just two raters, where standard correlational formula can be used. When more than two raters are involved, it would be possible to compare each rater with each of the others or to compare each rater with the average of the other raters by standard correlational methods. However, either procedure would be both cumbersome and susceptible to ambiguous interpretation. A preferable approach has been developed by Ebel through a modification of a standard Spearman-Brown formula (Guilford, 1956). The process leads to computation of a ratio which is algebraically equivalent to the standard correlation coefficient (r).

The Spearman-Brown (Ebel) coefficient of reliability among the 27 raters was 0.822. The computation used the standardized mean scores per task for 247 tasks, i.e., the matrix was composed of all tasks which has been rated by all raters. The 18 tasks which had not been rated by all raters were deleted to simplify the calculation. The coefficient 0.822 is well within acceptable limits (e.g., rigorous cut-off at $r < 0.600$) and indicates remarkably high agreement among raters. From this test, it can be concluded that the rating procedure was highly reliable.

3.5.5 Confidence of Task Rankings

The automation index for each task was a composite or average score across raters and capability dimensions. Confidence in the task automation index was, therefore, a matter of the variability among the aggregated scores. The basic proposition for confidence analysis was that, if the overall variability were low, it would be possible to attach substantial confidence to the automation index. Conversely, if variability were high, it could be deduced that there was a problem associated with the rating process and that there should be weak confidence in the resulting automation index.

There were two potential sources of variability in the ratings. First, there could be differences of opinion among the raters with respect to the scores assigned for any given performance capability in the task. That is, raters could exhibit either disagreement or consensus along a given capability dimension. The other source of variance lay in the possible disparity among the group scores across the different performance capabilities associated with the task. This disparity, or lack of consistency, would be demonstrated, for example, if the mean ratings for sensing were low and the mean ratings for information processing were high for a particular task.

For the purpose of analysis, the two sources of variability were designated consensus and consistency. Consensus was a property manifested by raters along a given performance dimension. Consistency was a property of the ratings across performance capabilities. Since both consensus and consistency could be either high or low, it was possible to define four conditions:

1. High confidence (high consensus and high consistency)
2. Medium confidence (high consensus but low consistency)
3. Medium confidence (low consensus but high consistency)
4. Low confidence (low consensus and low consistency)

The strategy for confidence analysis was first to compute the overall variability across raters and capabilities for each task automation index. If the overall variability was low, it was assumed that the ratings exhibited high consensus and high consistency, and so were accorded high confidence. If, on the other hand, the overall variability was high, the automation index was regarded as suspect and subjected to further analysis to isolate the source of variability.

The first step in this analysis was to determine whether the variability lay in the area of low consensus or low consistency or both. There was also a special case to be considered. If the task in question had been rated on only one capability, it was obvious that there could be no variability in consistency and that the problem had to lie in the realm of consensus. Such cases were routed to a subsidiary analytic channel.

The variability associated with those tasks rated on two or more capabilities were broken down by a method based on the conventional analysis of variance. The magnitude of the variance due to interrater differences was compared by direct inspection with the magnitude of the variance due to differential scoring of capabilities. This allowed the suspect tasks to be assigned to one or the other of the medium confidence subsets or to the low confidence category.

After such assignment, the task in question was examined by non-statistical means to attempt to determine the source of difficulty. The logic was that the high consensus/low consistency cases probably stemmed either from a faulty task analysis (i.e., the task incorporated disparate components which should have been treated as separate tasks) or from an erroneous designation of performance capabilities. The low consensus/high consistency cases (which included the above mentioned special cases of low consensus on a single dimension) were more challenging. One possible explanation was that the task description was not sufficiently clear and that raters were confused as to what type of performance attributes were required. Alternatively, it was possible that the task represented a controversial area of automation and that the divergence of opinion denoted the need for special study, (e.g., through man-in-the-loop simulation). The low consensus/low consistency cases were taken to be a frank failure of the rating procedure. The infrequent occurence of the low confidence ratings (10 of 265 tasks, or 3.8%) was, however, encouraging in that it suggested the overall success of the rating procedure.

For all the medium and low confidence task ratings, the procedure was to resolve the problem by restudy of the task descriptions and performance requirements and to make an automation assignment on logical grounds. Most often, the solution was to consider the functional context of the task and to assign the task to an automation level consistent with other associated tasks. The tasks with questionable ratings are identified and discussed in Section 4.1.

3.5.6 Summary of Data Analysis Procedures

The following is a list of the data processing routines and statistical measures employed to develop and test the index of automation, unless otherwise indicated, the term "mean" refers to the arithmetic mean. An asterisk denotes a critical end product, i.e., one of the three forms of the automation index. See also Appendix F for a statement of mathematical definitions and formulae.

1. Computations Based on Raw Scores:

   A. Distribution function per rater
   B. Overall distribution function
   C. Mean and standard deviation per rater
   D. Overall mean and standard deviation
   E. Mean and standard deviation for capability category per rater
   F. Overall mean and standard deviation per capability category
   *G. Mean, standard deviation and standard error of the mean per task
   *H. Geometric mean per task

2. Transformation of Scores

   A. Computation of Z-score matrix based on the standard deviation per capability per rater

   B. Transformation of Z-score matrix to a 20-interval standard scale

   C. Compilation of a standard-score matrix

3. Computations Based on Standard Scores

   A. Mean and standard deviation per rater

   B. One-way analysis of variance for group bias effects

   C. Mean per task per rater

   D. Spearman-Brown interrater reliability using all task means per rater

   *E. Mean, standard deviation and standard error of the mean per task

4.0 LEVELS OF MAN-MACHINE ALLOCATION

4.1 AUTOMATION INDEX

The objective of the rating procedure and the extensive data analysis was to develop a reliable discriminant measure of the ordinal position of air traffic control tasks along a continuum of man-machine performance capability. This measure, designated as the automation index, was intended to provide a way of ranking tasks with respect to the priority of consideration for assignment to automated resources. It has been pointed out earlier, but must be reemphasized, that the automation index is not to be interpreted in an absolute sense. It does not purport to show that tasks should be automated or, conversely, reserved for human performance. Rather, the automation index is a way of identifying the order in which candidate tasks should be examined. Thus, for any level of automation which may be postulated, the automation index helps to isolate from the entire functional gamut those tasks which, in terms of the type of required performance attributes, are most like each other. In short, the automation index is intended to serve not as a substitute for conventional system analysis but as a framework to guide the analytic process.

In the earlier discussion of the strategy for aggregation of individual ratings (subsection 3.5.2), it was suggested that there were three possible methods for deriving the automation index. They were: 1) the arithmetic mean of raw scores, 2) the geometric mean of raw scores, and 3) the arithmetic mean of the converted scores, each on a per task basis. It was also stated that the desirable properties of the automation index were discriminability among tasks and stability (reliability) across raters. Tests of the automation indices developed by each of these methods indicated that the geometric mean provided the best balance of these two properties. Consequently, whenever the term automation index is used hereafter, it refers to the geometric mean of the ratings assigned by all raters for all performance capabilities in a given task, where the geometric mean is defined as the n^{th} root of the product of n terms.

The discussion which follows addresses itself to three topics. First is a presentation of the automation indices for the 265 generic air traffic control tasks. Next is an examination of the statistical evidence supporting the confidence level of task rankings obtained by the automation index. Finally, there is a brief interpretation of the findings and an explanation of the disposition of certain anomalous cases.

4.1.1 Task Ranking by Automation Index

Computation of the automation index for the 265 tasks produced values with a range of 18.51 to 77.32, providing nearly a 60-point scale. The direction of the scale is such that the higher values represent tasks which the raters believed to require the more machine-like performance attributes. The lower values indicate rater opinion that man-like performance is required. Once more, the reader is cautioned that the automation index is to be interpreted only as a relative scale and that no absolute categorization of automatability is to be imputed to the values obtained.

Tables 4.1-1 and 4.1-2 on the following pages provide listings of task automation indices. Table 4.1-1 contains the automation index and ranking for tasks listed serially by function. The same information is given in Table 4.1-2, but with the tasks rearranged by rank order of automation index. In each table the ranking is from highest to lowest automation index value, i.e., from most to least automatable.

Figure 4.1-1, which appears on page 4.1-24, shows the tasks arrayed on an ordinal scale, thereby allowing the reader to see more readily how tasks cluster by automation index. Figure 4.1-1 has been prepared such that it may be folded out alongside Table 4.1-1 or Table 4.1-2 for ease of comparison.

For the reader interested in comparing the automation index based on the geometric mean with those derived from mean raw scores or mean converted scores, see Appendix E.

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS

TASK NO.	TITLE	AI*	RANK
	FUNCTION 1.0 - PROVIDE FLIGHT PLANNING INFORMATION		
1.1.1	Accept Data Link Request	52.1	83
1.1.2	Accept Telephone Request	40.7	145
1.1.3	Enter Request into System	42.0	142
1.2.1	Select Preformatted Reply	44.2	131
1.2.2	Retrieve Information Requested	54.9	67
1.3.1	Compile Non-Preformatted Response	42.6	139
1.3.2	Display Information Requested	52.1	83
1.3.3	Transmit Requested Information via Telephone	36.7	156
	FUNCTION 2.0 - CONTROL TRAFFIC FLOW		
2.1.1	Select Terminal or Jurisdiction and Time Period to be Considered	45.6	122
2.1.2	Determine Effects of Weather on Capacity	47.8	111
2.1.3	Determine Effects of Airspace Restrictions on Capacity	45.1	125
2.1.4	Determine Effects of Ground Equipment Capability and Status on Capacity	44.6	128
2.1.5	Determine Effects of Flight Hazards on Capacity	40.8	144
2.1.6	Determine Total Effect on Capacity	53.6	75
2.2.1	Determine Jurisdiction/Terminal Demand Due to Commercial Schedules	58.5	47
2.2.2	Process and Store Reservations	56.2	59
2.2.3	Determine Jurisdiction/Terminal Demand Due to Reservations	58.4	48
2.2.4	Determine Total Jurisdiction/Terminal Demand	59.7	42
2.3.1	Compare Capacity with Demand	53.6	75
2.3.2	Determine Origins of Demand in Capacity Overload Situations	49.9	97
2.3.3	Determine What Number of Aircraft are to be Delayed for What Period of Time	60.2	39
2.3.4	Determine where delays are to be Absorbed	61.9	34
2.3.5	Formulate Flow Control Directives	66.5	20

*AI - Automation Index

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
	FUNCTION 3.0 - PREPARE FLIGHT PLAN		
3.1.1	Specify Desired Destination and Route Information	37.3	155
3.1.2	Specify Aircraft and Pilot Information	25.5	169
3.1.3	Specify Type Flight Plan and Special Services Desired	25.7	168
3.2.1	Obtain Operational, Environmental, and Regulatory Information for Desired Route and Destination	46.2	119
3.2.2	Determine Modifications Required to Make Preliminary Flight Plan Consistent with Operational, Environmental and Regulatory Information	46.5	117
3.2.3	Determine Effects of Required Modifications on Flight Intentions	49.4	99
3.3.1	Compile Flight Plan	44.7	127
3.3.2	Check Flight Plan for Internal Consistency	39.8	149
3.3.3	Submit Flight Plan	19.4	175
	FUNCTION 4.0 - PROCESS FLIGHT PLAN		
4.1.1	Determine Points for Which ETOV's are to be Computed	40.4	146
4.1.2	Compute ETOV's/ETA	52.3	81
4.2.1	Compare Flight Plan with Aircraft Capability and Status	39.1	152
4.2.2	Compare Flight Plan with Operational and Environmental Conditions	45.2	124
4.2.3	Probe for Conflicts among Flight Plans	48.8	104
4.2.4	Compare Flight Plan with Flow Control Directives and Guidelines	47.1	114
4.2.5	Compare Flight Plan with Rules and Procedures	40.3	147
4.2.6	Compare Flight Plan with Flight Progress	44.7	127
4.2.7	Compare Flight Plan with User Class/Pilot Qualifications	32.1	165
4.2.8	Compile List of Discrepancies	37.9	154
4.2.9	Determine Flight Plan Priority	40.3	147
4.2.10	Determine Acceptability of Flight Plan	43.9	132
4.2.11	Identify Flight Plans That Must be Modified as a Result of this Approval	50.4	94

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
4.2.12	Inform Pilot of Flight Plan Approval	24.2	171
4.2.13	Determine Special Services Required	34.5	159
4.3.1	Determine Changes Required to Make Flight Plan Acceptable	52.7	78
4.3.2	Determine Responsibility to Modify the Flight Plan	40.2	148
4.3.3	Inform Pilot of Unacceptable Flight Plan	22.3	173
4.3.4	Compile Modified Flight Plan	45.7	121
4.4.1	Receive and Enter Pilot's Response	27.3	166
4.4.2	Cancel Flight Plan	18.5	176
4.4.3	Designate Responsible Jurisdictions	48.0	109
4.4.4	Designate Communication Links between ATM and Aircraft	43.8	133
	FUNCTION 5.0 - ISSUE CLEARANCES AND CLEARANCE CHANGES		
5.1.1	Determine if Identification Code Assignment is Required	44.7	127
5.1.2	Compare Flight Progress with Clearance Limit and EFC Time	54.5	70
5.1.3	Determine Pilot Intentions following Missed Approach	39.6	150
5.2.1	Assign Identification Code	56.2	59
5.2.2	Determine Clearance Tolerances	51.4	88
5.2.3	Determine Clearance Limit	59.2	45
5.2.4	Determine Required Clearance Instructions	55.6	61
5.3.1	Compile Clearance to be Issued	55.5	62
5.3.2	Transmit Clearance Message	24.4	170
5.3.3	Receive Acknowledgment of Clearance	36.0	157
	FUNCTION 6.0 - MONITOR AIRCRAFT PROGRESS		
6.1.1	Receive/Enter Correlated Position and Identification	68.6	13
6.1.2	Receive/Enter Position	71.0	8
6.1.3	Correlate Position and Identification	53.7	74
6.1.4	Request Aircraft Identity	34.0	161
6.1.5	Assign Arbitrary Aircraft Identification	44.3	130

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
6.2.1	Initiate Aircraft Actual Time-Position Profile	50.4	94
6.2.2	Update Aircraft Actual Time-Position Profile	56.3	58
6.3.1	Derive Rate of Change of Position	55.5	62
6.3.2	Compute Short-Range Extrapolations	77.3	1
6.3.3	Compute Long-Range Extrapolations	76.5	2
6.4.1	Determine Aircraft Readiness	58.5	47
6.4.2	Detect Aircraft Emergencies	62.8	31
6.4.3	Determine Nature of Emergency	58.5	47
6.4.4	Receive and Enter Aircraft Status Changes	50.4	94
6.4.5	Update Aircraft Status	43.4	135
6.4.6	Receive and Enter Reports of Aircraft Capability Changes	49.1	101
6.4.7	Update Aircraft Capability	50.0	96
	FUNCTION 7.0 - MAINTAIN CONFORMANCE WITH FLIGHT PLAN		
7.1.1	Specify Time Period to be Checked	46.3	118
7.1.2	Construct Pairs of Flight Plans to be Compared	70.1	9
7.1.3	Select Relevant Portion of Each Pair Member's Intended Time-Position Profile	53.9	72
7.1.4	Compare Intended Time-Position Profiles for Intersections in x, y, h & t	62.8	31
7.1.5	Propose Revised Flight Plan to Correct Long-Term Conflicts among Flight Plans	61.5	35
7.2.1	Determine Aircraft's Intended Present Position	52.3	81
7.2.2	Compute Deviations between Aircraft's Intended and Actual Present Position	73.5	4
7.3.1	Determine Aircraft's Intended Future Positions	59.8	41
7.3.2	Compute Short-Range Deviations (in x, y, h) from Flight Plan	68.6	13
7.3.3	Compute Long-Range Deviations (in t) from Flight Plan	66.9	18
7.4.1	Compare Deviations with Tolerances	60.8	37
7.4.2	Inform Pilot of Out-of-Tolerance Deviations	23.5	172
7.4.3	Receive Pilot's Response Concerning Resolution of Out-of-Tolerance Present and/or Long-Range Deviations	42.0	142

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
7.4.4	Develop Flight Plan Revisions to Correct Out-of-Tolerance Deviations	53.3	76
	FUNCTION 8.0 - ASSURE SEPARATION OF AIRCRAFT		
8.1.1	Select Airspace Volume and Time Frame	57.3	53
8.1.2	Predict Aircraft Paths	65.2	25
8.1.3	Identify Path Prediction Profiles for the Airspace and Time Frame	66.2	21
8.1.4	Pair Path Prediction Profiles for Conflict Comparison	65.6	24
8.1.5	Determine Conflict Probability for Each Pair	71.4	7
8.1.6	Determine Conflict Imminence for Each Pair	72.4	5
8.1.7	Determine Action Required	68.8	12
8.1.8	Monitor for Unexpected Deviations	62.1	33
8.1.9	Determine if Action Classification has been Updated	52.4	80
8.2.1	Hypothesize Performance Changes	58.0	50
8.2.2	Analyze Performance Change for Conflicts	67.6	16
8.2.3	Format Performance Change Message	54.8	68
8.2.4	Transmit Performance Change Message to Pilot	42.6	139
8.2.5	Determine Performance Change Status	49.1	101
	FUNCTION 9.0 - CONTROL SPACING OF AIRCRAFT		
9.1.1	Determine Identity and ETA of Arriving Aircraft	54.9	67
9.1.2	Determine Identity and ETD of Departing Aircraft	53.7	74
9.1.3	List Arriving and Departing Aircraft and ETA/ETD	63.3	29
9.2.1	Determine Airport Capacity		
9.2.2	Analyze Predicted Schedule for Alternating Periods of Excess Demand and Slack	51.3	89
9.3.1	Analyze Temporal Distribution of Arrivals and Departures	54.9	67
9.3.2	Allocate Blocks of Time for Arrivals and Departures	47.3	113
9.4.1	Compare Predicted Arrival and Departure Times with Runway Schedule	62.1	33
9.4.2	Change ETA's and ETD's to be Compatible with Runway Schedule	62.6	32
9.5.1	Select Sequence/Schedule Change to be Implemented	51.2	90

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
9.5.2	Hypothesize Performance Change Required to Implement Desired Sequence/Schedule	53.8	73
9.5.3	Check Proposed Performance Change for Predicted Conflict	57.2	54
9.5.4	Assess Control Implications of Performance Required to Implement Sequence/Schedule Change	57.2	54
9.5.5	Submit Performance Changes within Existing Flight Plan to Clearance Function	26.8	167
9.5.6	Propose Revised Flight Plan to Implement Sequence/ Schedule Change	42.8	138
9.5.7	Submit Revised Flight Plan for Approval	21.4	174
	FUNCTION 11.0 - PROVIDE AIRCRAFT GUIDANCE		
11.1.1	Determine Desired Position	58.4	48
11.1.2	Determine Requirements for Further Vectoring	54.7	69
11.2.1	Measure Course and Distance	52.4	80
11.2.2	Compute Time Interval	55.6	61
11.2.3	Compute Ground Speed	67.9	14
11.2.4	Compute Altitude Difference	64.0	28
11.3.1	Compute Airspeed	69.9	11
11.3.2	Compute Vertical Speed	69.9	11
11.3.3	Compute Heading	65.8	23
11.4.1	Compute Heading Command	56.7	56
11.4.2	Compute Airspeed Command	56.6	57
11.4.3	Compute Vertical Speed Command	56.6	57
11.5.1	Compile Vectoring Instructions	54.0	71
11.5.2	Transmit Vectoring Instructions to Pilot	41.9	143
11.5.3	Assess Aircraft Response	55.6	61
	FUNCTION 12.0 - ISSUE FLIGHT ADVISORIES AND INSTRUCTIONS		
12.1.1	Receive Pilot's Request for Information	45.7	121
12.1.2	Acknowledge Pilot Request for Information	34.4	160
12.1.3	Select Applicable Preformatted Messages	48.7	105
12.1.4	Retrieve Information Requested	57.1	55

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
12.1.5	Compile Special Response to Request	42.8	138
12.1.6	Transmit Preformatted Advisory to Pilot	35.0	158
12.1.7	Transmit Special Response to Pilot	33.9	162
12.2.1	Evaluate Advisory for Data Content	58.1	49
12.2.2	Determine Aircraft to Which Information Applies	52.0	84
12.2.3	Determine Method of Flight Advisory Distribution	51.0	92
12.2.4	Determine Distribution Position for Each Identified Aircraft	53.1	77
12.2.5	Determine Time of Simultaneous Distribution	51.7	86
12.2.6	Prepare Transmission Schedule	51.1	91
12.2.7	Correlate Present Position with Distribution Position	46.1	120
12.3.1	Determine Endangered Aircraft	51.5	87
12.3.2	Compile Alert Message	59.9	40
12.3.3	Transmit Warning Advisory to Pilot	32.7	164
12.3.4	Receive Pilot's Response	39.2	151
	FUNCTION 13.0 - HANDOFF		
13.1.1	Correlate Aircraft Position with Jurisdictional Boundaries	45.7	121
13.1.2	Determine Functions to be Transferred	53.7	74
13.1.3	Correlate Aircraft Position with Airspace Structure Boundaries	49.6	98
13.1.4	Receive Pilot's Request for Transfer of Responsibility	44.5	129
13.1.5	Determine Acceptability to Jurisdictions Involved	55.2	64
13.2.1	Determine if Communication Channel Change is Required	45.2	124
13.2.2	Determine Availability of Appropriate Channels	43.1	137
13.2.3	Designate Channel to be Used	49.3	100
13.3.1	Transfer Responsibility for Control	36.7	156
13.3.2	Compile Required Information for Clearance Function	51.2	90
	FUNCTION 14.0 - MAINTAIN SYSTEM RECORDS		
14.1.1	Detect Information Requiring Operational Report	46.8	116
14.1.2	Retrieve Applicable Operational Report Format	49.0	102

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
14.1.3	Enter Detected Information	50.8	93
14.1.4	Determine Necessity for Additional Information	48.9	103
14.1.5	Retrieve Additional Information	49.3	100
14.2.1	Classify Data Elements	53.6	75
14.2.2	Assign Appropriate Identifiers	55.4	63
14.2.3	Determine if Data Transform/Reformat is Required	58.9	46
14.2.4	Transform/Reformat Data Element	59.4	43
14.2.5	Enter Data Element into Storage	66.8	19
14.3.1	Determine if Report is Available	52.5	79
14.3.2	Retrieve Format	48.5	107
14.3.3	Develop Format	45.5	123
14.3.4	Retrieve Required Data	53.1	77
14.3.5	Analyze Data	60.9	36
14.3.6	Compile Report	59.3	44
	FUNCTION 15.0 - PROVIDE ANCILLARY AND SPECIAL SERVICES		
15.1.1	Compile/update Description of Special Service Required	39.2	151
15.1.2	Monitor Progress of Service	42.4	140
15.2.1	Determine Requirement for Special Flight Plan Priority	44.3	130
15.2.2	Establish Area of Restriction	44.6	128
15.2.3	Determine Guidance Service Required	40.7	145
15.2.4	Determine Special Separation Minima	45.0	126
15.2.5	Determine Advisories Required	42.3	141
15.2.6	Determine Necessity for Issuance of NOTAM(s)	39.1	152
	FUNCTION 16.0 PROVIDE EMERGENCY SERVICES		
16.1.1	Determine Adequacy of Emergency Description	50.2	95
16.1.2	Request Additional Required Information	47.6	112
16.1.3	Compile Description of Emergency	46.8	116
16.2.1	Determine Required Ground Support Assistance	48.6	106
16.2.2	Determine Assistance Required from Other Aircraft	46.1	120

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
16.2.3	Determine Aircraft to Provide Assistance	56.1	60
16.2.4	Issue Instructions to Aircraft Providing Assistance	46.1	120
16.2.5	Determine Required Technical Instructions to Aircraft in Emergency Situation	52.7	78
16.2.6	Develop Emergency Flight Plan	60.6	38
16.2.7	Determine Requirement for Use of Emergency Communication Link	52.2	82
16.2.8	Inform Pilot of Change to Emergency Frequency Link	38.4	153
16.2.9	Determine Required Guidance Assistance	51.5	87
16.2.10	Determine Required Response to Emergency	41.9	143
	FUNCTION 17.0 - MAINTAIN SYSTEM CAPABILITY AND STATUS INFORMATION		
17.1.1	Determine if Weather Observation Report is Required	47.0	115
17.1.2	Determine if Supplemental Data is Required	43.3	136
17.1.3	Request PIREP	44.3	130
17.1.4	Receive Supplemental Data	33.5	163
17.1.5	Make Weather Observation Report	47.9	110
17.1.6	Transmit Weather Observation Report	47.3	113
17.1.7	Receive and Enter Weather Information	43.5	134
17.1.8	Store Weather Information	71.9	6
17.2.1	Determine Data Base Item Affected	48.4	108
17.2.2	Retrieve Affected Data Base Item	64.7	27
17.2.3	Determine Required Change to the Data Base Item	52.7	78
17.2.4	Purge Affected Data Base Item	44.5	129
17.2.5	Format New Data Base Item	48.4	105
17.2.6	Store Data Base Item	65.0	26
17.3.1	Determine Data Base Item Affected	48.4	108
17.3.2	Retrieve Affected Data Base Item	64.7	27
17.3.3	Determine Required Change to the Data Base Item	52.7	78
17.3.4	Purge Affected Data Base Item	44.5	129
17.3.5	Format New Data Base Item	48.4	108
17.3.6	Store Data Base Item	65.0	26

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
17.4.1	Determine Data Base Item Affected	48.4	108
17.4.2	Retrieve Affected Data Base Item	64.7	27
17.4.3	Determine Required Change to the Data Base Item	52.7	78
17.4.4	Purge Affected Data Base Item	44.5	129
17.4.5	Format New Data Base Item	48.4	108
17.4.6	Store Data base item	65.0	26
17.5.1	Determine Data Base Item Affected	48.4	108
17.5.2	Retrieve Affected Data Base Item	64.7	27
17.5.3	Determine Required Change to the Data Base Item	52.7	78
17.5.4	Purge Affected Data base Item	44.5	129
17.5.5	Format New Data Base Item	48.4	108
17.5.6	Store Data Base Item	65.0	26
17.6.1	Determine Data Base Item Affected	48.4	108
17.6.2	Retrieve Affected Data Base Item	64.7	27
17.6.3	Determine Required Change to the Data Base Item	52.7	78
17.6.4	Purge Affected Data Base Item	44.5	129
17.6.5	Format New Data Base Item	48.4	108
17.6.6	Store Data Base Item	65.0	26
17.7.1	Monitor COMM and NAV Systems for Status Change	55.4	63
17.7.2	Activate Standby Equipment	51.8	85
17.7.3	Retrieve Affected Data Base Item	53.6	75
17.7.4	Format New Data Base Item	51.5	87
17.7.5	Store Data Base Item	67.8	15
17.8.1	Monitor Ground Facilities for Status Change	59.2	45
17.8.2	Activate Standby Equipment	52.0	84
17.8.3	Retrieve Affected Data base Item	53.6	75
17.8.4	Format New Data Base Item	51.5	87
17.8.5	Store Data Base Item	67.8	15
17.9.1	Receive and Index User Class Information	43.5	134
17.9.2	Retrieve Affected Data base Item	57.8	51
17.9.3	Determine Change REquired	55.1	65
17.9.4	Purge Affected User Class Data Base Item	46.2	119

TABLE 4.1-1 AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	TITLE	AI	RANK
17.9.5	Format User Class Data Base Item	55.0	66
17.9.6	Store User Class Data Base Item	66.0	22
17.10.1	Maintain Tallies of Active Flight Plans	67.5	17
17.10.2	Compile ETD's, ETOV's, and ETA's	70.0	10
17.10.3	Store Traffic Data	74.0	3
17.11.1	Determine Requirement for Preformatted Data Modules	57.5	52
17.11.2	Compile Preformatted Data Modules	63.0	30

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX

RANK*	AI	TASK NO.	TITLE
1	77.3	6.3.2	Compute Short-Range Extrapolations
2	76.5	6.3.3	Compute Long-Range Extrapolations
3	74.0	17.10.3	Store Traffic Data
4	73.5	7.2.2	Compute Deviations between Aircraft's Intended and Actual Present Position
5	72.4	8.1.6	Determine Conflict Imminence for Each Pair
6	71.9	17.1.8	Store Weather Information
7	71.4	8.1.5	Determine Conflict Probability for Each Pair
8	71.0	6.1.2	Receive/Enter Position
9	70.1	7.1.2	Construct Pairs of Flight Plans to be Compared
10	70.0	17.10.2	Compile ETD's, ETOV's, and ETA's
11	69.9	11.3.1	Compute Airspeed
11	69.9	11.3.2	Compute Vertical Speed
12	68.8	8.1.7	Determine Action Required
13	68.6	6.1.1	Receive/Enter Correlated Position and Identification
13	68.6	7.3.2	Compute Short-Range Deviations (in x, y and h) from Flight Plan
14	67.9	11.2.3	Compute Ground Speed
15	67.8	17.7.5	Store Data Base Item
15	67.8	17.8.5	Store Data Base Item
16	67.6	8.2.2	Analyze Performance Change for Conflicts
17	67.5	17.10.1	Maintain Tallies of Active Flight Plans
18	66.9	7.3.3	Compute Long-Range Deviations (in t) from Flight Plan
19	66.8	14.2.5	Enter Data Element into Storage
20	66.5	2.3.5	Formulate Flow Control Directives
21	66.2	8.1.3	Identify Path Prediction Profiles for the Airspace and Time Frame
22	66.0	17.9.6	Store User Class Data Base Item
23	65.8	11.3.3	Compute Heading
24	65.6	8.1.4	Pair Path Prediction Profiles for Conflict Comparison
25	65.2	8.1.2	Predict Aircraft Paths
26	65.0	17.2.6	Store Data Base Item
26	65.0	17.3.6	Store Data Base Item

*The rank order is from most to least automatable.

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
26	65.0	17.4.6	Store Data Base Item
26	65.0	17.5.6	Store Data Base Item
26	65.0	17.6.6	Store Data Base Item
27	64.7	17.2.2	Retrieve Affected Data Base Item
27	64.7	17.3.2	Retrieve Affected Data Base Item
27	64.7	17.4.2	Retrieve Affected Data Base Item
27	64.7	17.5.2	Retrieve Affected Data Base Item
27	64.7	17.6.2	Retrieve Affected Data Base Item
28	64.0	11.2.4	Compute Altitude Difference
29	63.3	9.1.3	List Arriving and Departing Aircraft and ETA/ETD
30	63.0	17.11.2	Compile Preformatted Data Modules
31	62.8	6.4.2	Detect Aircraft Emergencies
31	62.8	7.1.4	Compare Intended Time-Position Profiles for Intersections in X, Y, H, & T
32	62.6	9.4.2	Change ETA's and ETD's to be Compatible with Runway Schedule
33	62.1	8.1.8	Monitor for Unexpected Deviations
33	62.1	9.4.1	Compare Predicted Arrival and Departure Times with Runway Schedule
34	61.9	2.3.4	Determine Where Delays are to be Absorbed
35	61.5	7.1.5	Propose Revised Flight Plan to Correct Long-Term Conflicts Among Flight Plans
36	60.9	14.3.5	Analyze Data
37	60.8	7.4.1	Compare Deviations with Tolerances
38	60.6	16.2.6	Develop Emergency Flight Plan
39	60.2	2.3.3	Determine What Number of Aircraft are to be Delayed for What Period of Time
40	59.9	12.3.2	Compile Alert Message
41	59.8	7.3.1	Determine Aircraft's Intended Future Positions
42	59.7	2.2.4	Determine Total Jurisdiction/Terminal Demand
43	59.4	14.2.4	Transform/Reformat Data Element
44	59.3	14.3.6	Compile Report
45	59.2	5.2.3	Determine Clearance Limit

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
45	59.2	17.8.1	Monitor Ground Facilities for Status Change
46	58.9	14.2.3	Determine if Data Transform/Reformat is Required
47	58.5	2.2.1	Determine Jurisdiction/Terminal Demand Due to Commercial Schedules
47	58.5	6.4.1	Determine Aircraft Readiness
47	58.5	6.4.3	Determine Nature of Emergency
48	58.4	2.2.3	Determine Jurisdiction/Terminal Demand Due to Reservations
48	58.4	11.1.1	Determine Desired Position
49	58.1	12.2.1	Evaluate Advisory for Data Content
50	58.0	8.2.1	Hypothesize Performance Changes
51	57.8	17.9.2	Retrieve Affected Data Base Item
52	57.5	17.11.1	Determine Requirement for Preformatted Data Modules
53	57.3	8.1.1	Select Airspace Volume and Time Frame
54	57.2	9.5.3	Check Proposed Performance Change for Predicted Conflict
54	57.2	9.5.4	Assess Control Implications of Performance Required to Implement Sequence/Schedule Change
55	57.1	12.1.4	Retrieve Information Requested
56	56.7	11.4.1	Compute Heading Command
57	56.6	11.4.2	Compute Airspeed Command
57	56.6	11.4.3	Compute Vertical Speed Command
58	56.3	6.2.2	Update Aircraft Actual Time-Position Profile
59	56.2	2.2.2	Process and Store Reservations
59	56.2	5.2.1	Assign Identification Code
60	56.1	16.2.3	Determine Aircraft to Provide Assistance
61	55.6	5.2.4	Determine Required Clearance Instructions
61	55.6	11.2.2	Compute Time Interval
61	55.6	11.5.3	Assess Aircraft Response
62	55.5	5.3.1	Compile Clearance to be Issued
62	55.5	6.3.1	Derive Rate of Change of Position
63	55.4	14.2.2	Assign Appropriate Identifiers
63	55.4	17.7.1	Monitor COMM and NAV Systems for Status Change

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
64	55.2	13.1.5	Determine Acceptability to Jurisdictions Involved
65	55.1	17.9.3	Determine Change Required
66	55.0	17.9.5	Format User Class Data Base Item
67	54.9	1.2.2	Retrieve Information Requested
67	54.9	9.1.1	Determine Identity and ETA of Arriving Aircraft
67	54.9	9.3.1	Analyze Temporal Distribution of Arrivals and Departures
68	54.8	8.2.3	Format Performance Change Message
69	54.7	11.1.2	Determine Requirements for Further Vectoring
70	54.5	5.1.2	Compare Flight Progress with Clearance Limit and EFC Time
71	54.0	11.5.1	Compile Vectoring Instructions
72	53.9	7.1.3	Select Relevant Portion of each Pair Member's Intended Time-Position Profile
73	53.8	9.5.2	Hypothesize Performance Change Required to Implement Desired Sequence/Schedule
74	53.7	6.1.3	Correlate Position and Identification
74	53.7	9.1.2	Determine Identity and ETD of Departing Aircraft
74	53.7	13.1.2	Determine Functions to be Transferred
75	53.6	2.1.6	Determine Total Effect on Capacity
75	53.6	2.3.1	Compare Capacity with Demand
75	53.6	14.2.1	Classify Data Elements
75	53.6	17.7.3	Retrieve Affected Data Base Item
75	53.6	17.8.3	Retrieve Affected Data Base Item
76	53.3	7.4.4	Develop Flight Plan Revisions to Correct Out-of-Tolerance Deviations
77	53.1	12.2.4	Determine Distribution Position for each Identified Aircraft
77	53.1	14.3.4	Retrieve Required Data
78	52.7	4.3.1	Determine Changes Required to Make Flight Plan Acceptable
78	52.7	16.2.5	Determine Required Technical Instructions to Aircraft in Emergency Situation
78	52.7	17.2.3	Determine Required Change to the Data Base Item

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
78	52.7	17.3.3	Determine Required Change to Data Base Item
78	52.7	17.4.3	Determine Required Change to Data Base Item
78	52.7	17.5.3	Determine Required Change to Data Base Item
78	52.7	17.6.3	Determine Required Change to Data Base Item
79	52.5	14.3.1	Determine if Report is Available
80	52.4	8.1.9	Determine if Action Classification has been Updated
80	52.4	11.2.1	Measure Course ana Distance
81	52.3	4.1.2	Compute ETOV's/ETA
81	52.3	7.2.1	Determine Aircraft's Intended Present Position
82	52.2	16.2.7	Determine Requirement for Use of Emergency Communication Link
83	52.1	1.1.1	Accept Data Link Request
83	52.1	1.3.2	Display Information Requested
84	52.0	12.2.2	Determine Aircraft to Which Information Applies
84	52.0	17.8.2	Activate Standby equipment
85	51.8	17.7.2	Activate Standby Equipment
86	51.7	12.2.5	Determine Time of Simultaneous Distribution
87	51.5	12.3.1	Determine Endangered Aircraft
87	51.5	16.2.9	Determine Required Guidance Assistance
87	51.5	17.7.4	Format New Data Base Item
87	51.5	17.8.4	Format New Data Base Item
88	51.4	5.2.2	Determine Clearance Tolerances
89	51.3	9.2.2	Analyze Predicted Schedule for Alternating Periods of Excess Demand and Slack
90	51.2	9.5.1	Select Sequence/Schedule Change to be Implemented
90	51.2	13.3.2	Compile Required Information for Clearance Function
91	51.1	12.2.6	Prepare Transmission Schedule
92	51.0	12.2.3	Determine Method of Flight Advisory Distribution
93	50.8	14.1.3	Enter Detected Information
94	50.4	4.2.11	Identify Flight Plans that must be Modified as a Result of this Approval
94	50.4	6.2.1	Initiate Aircraft Actual Time-Position Profile

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
94	50.4	6.4.4	Receive and Enter Aircraft Status Changes
95	50.2	16.1.1	Determine Adequacy of Emergency Description
96	50.0	6.4.7	Update Aircraft Capability
97	49.9	2.3.2	Determine Origins of Demand in Capacity Overload Situations
98	49.6	13.1.3	Correlate Aircraft Position with Airspace Structure Boundaries
99	49.4	3.2.3	Determine Effects of Required Modifications on Flight Intentions
100	49.3	13.2.3	Designate Channel to be Used
100	49.3	14.1.5	Retrieve Additional Information
101	49.1	6.4.6	Receive and Enter Reports of Aircraft Capability Changes
101	49.1	8.2.5	Determine Performance Change Status
102	49.0	14.1.2	Retrieve Applicable Operational Report Format
103	48.9	14.1.4	Determine Necessity for Additional Information
104	48.8	4.2.3	Probe for Conflicts Among Flight Plans
105	48.7	12.1.3	Select Applicable Preformatted Messages
106	48.6	16.2.1	Determine Required Ground Support Assistance
107	48.5	14.3.2	Retrieve Format
108	48.4	17.2.1	Determine Data Base Item Affected
108	48.4	17.2.5	Format New Data Base Item
108	48.4	17.3.1	Determine Data Base Item Affected
108	48.4	17.3.5	Format New Data Base Item
108	48.4	17.4.1	Determine Data Base Item Affected
108	48.4	17.4.5	Format New Data Base Item
108	48.4	17.5.1	Determine Data Base Item Affected
108	48.4	17.5.5	Format New Data Base Item
108	48.4	17.6.1	Determine Data Base Item Affected
108	48.4	17.6.5	Format New Data Base Item
109	48.0	4.4.3	Designate Responsible Jurisdictions
110	47.9	17.1.5	Make Weather Observation Report
111	47.8	2.1.2	Determine Effects of Weather on Capacity

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
112	47.6	16.1.2	Request Additional Required Information
113	47.3	9.3.2	Allocate Blocks of Time for Arrivals and Departures
113	47.3	17.1.6	Transmit Weather Observation Report
114	47.1	4.2.4	Compare Flight Plan with Flow Control Directives and Guidelines
115	47.0	17.1.1	Determine if Weather Observation Report is Required
116	46.8	14.1.1	Detect Information Requiring Operational Report
116	46.8	16.1.3	Compile Description of Emergency
117	46.5	3.2.2	Determine Modifications Required to Make Preliminary Flight Plan Consistent with Operational, Environmental and Regulatory Information
118	46.3	7.1.1	Specify Time Period to be Checked
119	46.2	3.2.1	Obtain Operational, Environmental, and Regulatory Information for Desired Route and Destination
119	46.2	17.9.4	Purge Affected User Class Data Base Item
120	46.1	12.2.7	Correlate Present Position with Distribution Position
120	46.1	16.2.2	Determine Assistance Required from Other Aircraft
120	46.1	16.2.4	Issue Instructions to Aircraft Providing Assistance
121	45.7	4.3.4	Compile Modified Flight Plan
121	45.7	12.1.1	Receive Pilot's Request for Information
121	45.7	13.1.1	Correlate Aircraft Position with Jurisdictional Boundaries
122	45.6	2.1.1	Select Terminal or Jurisdiction and Time Period to be Considered
123	45.5	14.3.3	Develop Format
124	45.2	4.2.2	Compare Flight Plan with Operational and Environmental Conditions
124	45.2	13.2.1	Determine if Communication Channel Change is Required
125	45.1	2.1.3	Determine Effects of Airspace Restrictions on Capacity
126	45.0	15.2.4	Determine Special Separation Minima
127	44.7	3.3.1	Compile Flight Plan
127	44.7	4.2.6	Compare Flight Plan with Flight Progress
127	44.7	5.1.1	Determine if Identification Code Assignment is Required
128	44.6	2.1.4	Determine Effects of Ground Equipment Capability and Status on Capability

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
128	44.6	15.2.2	Establish Area of Restriction
129	44.5	13.1.4	Receive Pilot's Request for Transfer of Responsibility
129	44.5	17.2.4	Purge Affected Data Base Item
129	44.5	17.3.4	Purge Affected Data Base Item
129	44.5	17.4.4	Purge Affected Data Base Item
129	44.5	17.5.4	Purge Affected Data Base Item
129	44.5	17.6.4	Purge Affected Data Base Item
130	44.3	6.1.5	Assign Arbitrary Aircraft Identification
130	44.3	15.2.1	Determine Requirement for Special Flight Plan Priority
130	44.3	17.1.3	Request PIREP
131	44.2	1.2.1	Select Preformatted Reply
132	43.9	4.2.10	Determine Acceptability of Flight Plan
133	43.8	4.4.4	Designate Communication Links Between ATM and Aircraft
134	43.5	17.1.7	Receive and Enter Weather Information
134	43.5	17.9.1	Receive and Index User Class Information
135	43.4	6.4.5	Update Aircraft Status
136	43.3	17.1.2	Determine if Supplemental Data is Required
137	43.1	13.2.2	Determine Availability of Appropriate Channels
138	42.8	9.5.6	Propose Revised Flight Plan to Implement Sequence/ Schedule Change
138	42.8	12.1.5	Compile Special Response to Request
139	42.6	1.3.1	Compile Non-Preformatted Response
139	42.6	8.2.4	Transmit Performance Change Message to Pilot
140	42.4	15.1.2	Monitor Progress of Service
141	42.3	15.2.5	Determine Advisories Required
142	42.0	1.1.3	Enter Request into System
142	42.0	7.4.3	Receive Pilot's Response Concerning Resolution of Out-of-Tolerance Present and/or Long-Range Deviations
143	41.9	11.5.2	Transmit Vectoring Instructions to Pilot
143	41.9	16.2.10	Determine Required Response to Emergency
144	40.8	2.1.5	Determine Effects of Flight Hazards on Capacity
145	40.7	1.1.2	Accept Telephone Request
145	40.7	15.2.3	Determine Guidance Service Required

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
146	40.4	4.1.1	Determine Points for Which ETOV's are to be Computed
147	40.3	4.2.5	Compare Flight Plan with Rules and Procedures
147	40.3	4.2.9	Determine Flight Plan Priority
148	40.2	4.3.2	Determine Responsibility to Modify the Flight Plan
149	39.8	3.3.2	Check Flight Plan for Internal Consistency
150	39.6	5.1.3	Determine Pilot Intentions Following Missed Approach
151	39.2	12.3.4	Receive Pilot's Response
151	39.2	15.1.1	Compile/Update Description of Special Service Required
152	39.1	4.2.1	Compare Flight Plan with Aircraft Capability and Status
152	39.1	15.2.6	Determine Necessity for Issuance of NOTAM(s)
153	38.4	16.2.8	Inform Pilot of Change to Emergency Frequency Link
154	37.9	4.2.8	Compile List of Discrepancies
155	37.3	3.1.1	Specify Desired Destination and Route Information
156	36.7	1.3.3	Transmit Requested Information via Telephone
156	36.7	13.3.1	Transfer Responsibility for Control
157	36.0	5.3.3	Receive Acknowledgement of Clearance
158	35.0	12.1.6	Transmit Preformatted Advisory to Pilot
159	34.5	4.2.13	Determine Special Services Required
160	34.4	12.1.2	Acknowledge Pilot Request for Information
161	34.0	6.1.4	Request Aircraft Identity
162	33.9	12.1.7	Transmit Special Response to Pilot
163	33.5	17.1.4	Receive Supplemental Data
164	32.7	12.3.3	Transmit Warning Advisory to Pilot
165	32.1	4.2.7	Compare Flight Plan with User Class/Pilot Qualifications
166	27.3	4.4.1	Receive and Enter Pilot's Response
167	26.8	9.5.5	Submit Performance Changes within Existing Flight Plan to Clearance Function
168	25.7	3.1.3	Specify Type Flight Plan and Special Services Desired
169	25.5	3.1.2	Specify Aircraft and Pilot Information
170	24.4	5.3.2	Transmit Clearance Message
171	24.2	4.2.12	Inform Pilot of Flight Plan Approval
172	23.5	7.4.2	Inform Pilot of Out-of-Tolerance Deviations

TABLE 4.1-2 RANKING OF AIR TRAFFIC CONTROL TASKS BY AUTOMATION INDEX (cont'd)

RANK	AI	TASK NO.	TITLE
173	22.3	4.3.3	Inform Pilot of Unacceptable Flight Plan
174	21.4	9.5.7	Submit Revised Flight Plan for Approval
175	19.4	3.3.3	Submit Flight Plan
176	18.5	4.4.2	Cancel Flight Plan

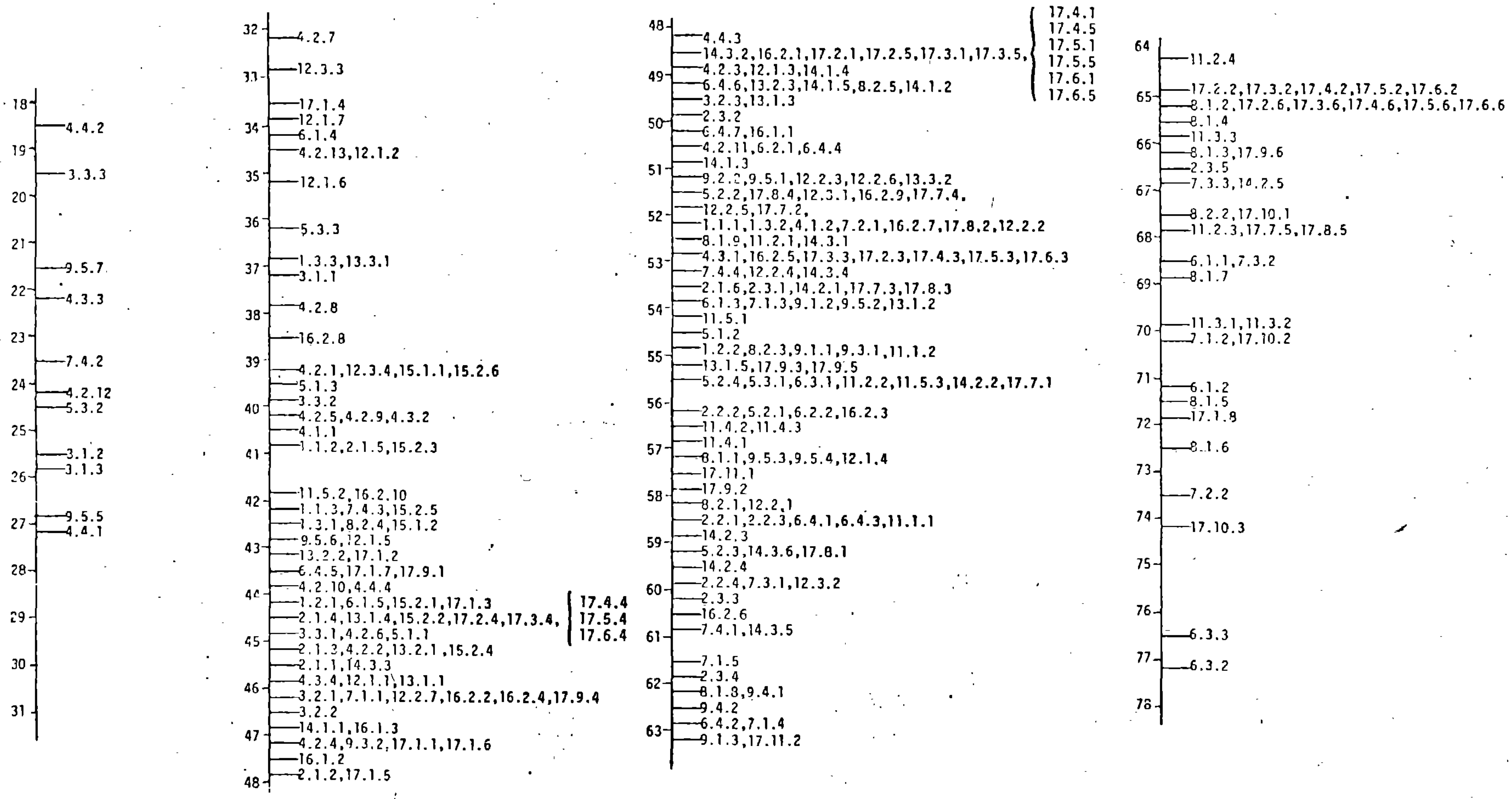

FIGURE 4.1-1 TASKS ARRAYED BY AUTOMATION INDEX

4.1.2 Confidence Analysis

Four indicators of rater score variability could be computed in the present case: the standard deviation (SD) for both the raw score average and the standard score average, and the standard error of the mean (SEM) for both averages. The standard error of the mean is useful in this case because it tends to weight the number of scores in such a way as to help equilibrate the tasks rated on only one performance capability with those rated on two or more such capabilities.

The four indicators were, of course, rather highly correlated among themselves. The procedure was to use the accord between indicators as a form of super-indicator. Thus, if a task had high values in all four indicators, it was specially suspect. High values on a combination of any three indicators made the task somewhat less suspect, and so forth.

Cutoff values were established for each indicator. Table 4.1-3 shows the range and cutoff values for each. The cutoff value was set to take in approximately 10% of the range but was adjusted to reflect gaps in the indicator rank ordering if these occurred near the 10% line. Tasks having indicator values higher than the cutoff value were designated as "problems" according to the combinatorial rule specified above.

Table 4.1-3

Range and Cut Off Value For Four Indicators of 'Confidence'

Indicator	Range	CUT OFF VALUE
Raw Score Standard Deviation	15.48 - 34.02	29.00
Raw Score Standard Error of Mean	2.18 - 6.80	5.00
Converted Score Standard Deviations	1.89 - 5.38	4.30
Converted Score Standard Error of Mean	0.27 - 1.08	0.70

The following tasks had high scores (low confidence level) on either three or all four of the indicators:

Task No.	Title	A.I. Rank*
1.3.3	Transmit Requested Information Via Telephone	156
3.3.3	Submit Flight Plan	175
4.2.12	Inform Pilot of Flight Plan Approval	171
5.3.2	Transmit Clearance Message	170
7.4.2	Inform Pilot of Out-of-Tolerances Deviations	172
8.2.4	Transmit Performance Change Message to Pilot	139
9.5.5	Submit Performance Changes within Existing Flight Plan to Clearance Function	167
9.5.7	Submit Revised Flight Plan for Approval	174
12.3.3	Transmit Warning Advisory to Pilot	164
13.3.1	Transfer Responsibility for Control	156

It is interesting to note some commonalities among these ten tasks in addition to their low confidence assignments. They are all tasks involving some form of message initiation; they are all tasks rated on a single capability (namely, Information Processing); and they are all tasks having a low Automation Index. Since all these tasks are rated on only one capability, the low confidence assignment is clearly due to lack of agreement among the raters.

The next group is composed of those tasks exhibiting low confidence on two indicators. These were:

Task No.	Title	A.I. Rank
** 1.3.2	Display Information Requested	83
2.1.1	Select Terminal or Jurisdiction and Time Period to be Considered	122
3.1.1	Specify Desired Destination and Route Information	155
4.1.1	Determine Points for Which ETOV's are to be Computed	146

* On the basis of 265 tasks entered into 176 ranks, where a high rank number rejects automation.

Task No.	Title	A.I. Rank
4.4.1	Receive and Enter Pilot's Response	166
4.4.2	Cancel Flight Plan	176
5.1.3	Determine Pilot Intentions Following Missed Approach	150
5.3.3	Receive Acknowledgment of Clearance	157
** 12.1.2	Acknowledge Pilot Request for Information	160
** 12.1.6	Transmit Preformatted Advisory to Pilot	158
16.1.2	Request Additional Required Information	112
** 16.2.4	Issue Instructions to Aircraft Providing Assistance	120
** 16.2.8	Inform Pilot of Change to Emergency Frequency Link	153
** 17.1.6	Transmit Weather Observation Report	113
* 17.2.6	Store Data Base Item	26
* 17.3.6	Store Data Base Item	26
* 17.4.6	Store Data Base Item	26
* 17.5.6	Store Data Base Item	26
* 17.6.6	Store Data Base Item	26
** 17.9.2	Retrieve Affected Data Base Item	51
* 17.10.3	Store Traffic Data	3

The tasks with a double asterisk are of the same type as those considered above: message initiation, single capability (Information Processing), and low confidence due to rater disagreement. The Automation Indices for this set of tasks, while more varied than the first group, still tend to show that these tasks were rejected for automation (or that there was rater uncertainty about them).

Those tasks with a single asterisk are of a different type. They are rated on a single capability and thus suffer exclusively from rater disagreement; but the capability in question was 'Storage and Retrieval'; and their ranking is low (indicating amenability to automation).

Those eight tasks without asterisks are of a still different type. All were scored on two or more capabilities. In these instances, the variability due to rater disagreement (lack of consensus) could be directly compared to the variability due to differential scores assigned to different capabilities. The Mean Sum of Squares factor derived from a conventional Analysis of Variance procedure was the figure upon which the comparisons were based.

In five of the eight cases (2.3.5, 4.1.1, 4.4.1, 4.4.2, and 16.1.2), the principal source of variability was rater disagreement. The other three tasks (2.1.1, 5.1.3, and 5.3.3) revealed a predominant lack of consistency in scoring across capabilities.

A final set of 21 tasks were identified as marginal with respect to confidence, in that they showed relatively high variability scores on only one indicator. They were:

Task No.	Title	A.I. Rank
2.1.5	Determine Effects of Flight Hazards on Capacity	144
2.1.6	Determine Total Effect on Capacity	75
2.2.2	Process and Store Reservations	59
3.2.2	Determine Modifications Required to Make Preliminary Flight Plan Consistent with Operational, Environmental and Regulatory Information	117
3.2.3	Determine Effects of Required Modifications on Flight Intentions	99
3.3.2	Check Flight Plan for Internal Consistency	149
4.2.8	Compile List of Discrepancies	154
6.1.4	Request Aircraft Identity	161
6.4.3	Determine Nature of Emergency	47
** 8.2.3	Format Performance Change Message	68
** 11.2.4	Compute Altitude Difference	28
** 12.1.7	Transmit Special Response to Pilot	162
13.2.1	Determine if Communication Channel Change is Required	124
* 13.2.3	Designate Channel to be Used	100
** 14.1.5	Retrieve Additional Information	100
* 14.2.5	Enter Data Element Into Storage	19
** 14.3.6	Compile Report	44
16.1.1	Determine Adequacy of Emergency Description	95
16.2.2	Determine Assistance Required from Other Aircraft	120
** 16.2.10	Determine Required Response to Emergency	143
* 17.9.6	Store User Class Data Base Item	22

Again, the double asterisk denotes tasks of the 'off' type; a single asterisk indicates tasks scored on one capability (13.2.3 on Decision Making; 14.2.5 and 17.9.6 on Storage and Retrieval). In all these cases, the low confidence was attributable to disagreement between raters. Of the remaining 12 tasks, each of which was scored on more than one capability, analysis revealed that rater disagreement was the dominant factor for eight and that lack of rater consistency across capabilities was the dominant factor for the remaining four (2.1.6, 2.2.2, 4.2.8, and 13.2.1).

In summary, a total of 52 tasks were sequestered because their automation indices were of questionable confidence. Of these, the 10 with the lowest confidence scores plus 13 of the remaining 42 were all of the same type. They were tasks which were rated on a single performance capability (information processing) and which involved some form of message initiation or communication. It was concluded that the explanation probably lay in a defect in the rating procedure.

It will be recalled that seven basic categories of performance were originally identified, but that the category of response was eliminated because it was considered highly system-specific. For the 23 tasks in question here, all of which involved response in their performance, raters were instructed to evaluate them as though they were information processing tasks. Since this designation was somewhat inappropriate, the raters were apparently confused -- with the result that their ratings showed extreme variability, producing automation indices of low confidence. In a way, this result tends to confirm the general validity of the rating procedure. That is, when the raters were confronted with a performance capability designation of dubious appropriateness, they were inclined to make highly variable and unreliable ratings. This conclusion is further strengthened by two additional findings. First, no other group of single performance capability tasks exhibited such a consistent pattern of unreliable ratings. Second, of all the 265 tasks rated, there were just 23 with response as their only performance requirement. All of them were designated (or perhaps misdesignated) as information processing tasks, and all produced ratings of low confidence.

There is no single explanation to account for the low confidence of the remaining 29 of the 52 suspect task ratings. Of these, 9 were rated on a single performance capability (8 on information storage and retrieval and 1 on decision making). Since the only possible source of variance in these scores was interrater disagreement, it is possible that these tasks are controversial as to their automatability. For the other 20 tasks, all of which were rated on two or more capabilities, the dominant factor in their low confidence was interrater disagreement in 12 cases and inconsistency in the other 8 cases. For these the variance can possibly be attributed either to some ambiguity in the task definition or to controversy over automation, or perhaps to both.

Thus, the original concept of categorization of low confidence tasks was essentially verified by the empirical findings. That is, it was expected that four sets of tasks would emerge: a preponderance with an acceptable confidence level, a small set representing some form of procedural error in the rating process, a small set arising from ambiguity of task definition, and a small set indicative of clear cut differences of opinion among raters. The only unexpected finding was that the tasks in the lowest confidence set were all alike in regard to the nature of the task and the condition of being rated on a single, and possibly misdesignated, performance capability.

Since there was statistical reason for confidence in the automation indices for 213 of the 265 tasks (80.4% of the cases), it was possible to proceed with the assignment of these tasks to automation levels. The proper placement of the remaining 52 tasks with suspect automation indices was somewhat less certain. However, in the interest of obtaining an initial approximation of automation levels and task allocations, it was decided to assign all tasks (including the 52 suspect ones) to automation levels on the basis of their automation index. This procedure had the advantage of providing some working hypotheses about the types of tasks to be allocated to machines at successive levels of automation. It also offered a context in which to evaluate the suspect tasks and determine their proper position on the man-machine performance continuum.

Thus, in the discussion of automation levels in the following section, all tasks have received a tentative assignment to man or machine resources at each level. In the case of the suspect tasks, this was merely a convenience in order to proceed with the analysis. Final disposition of these cases was deferred until later in the study when the recommended level of automation was selected.

4.2 AUTOMATION LEVELS

Five levels of automation were derived from the task rating data, then checked against automation levels in the present ATC system and against the logical relationships within the generic AATMS functional analysis. The paragraphs that follow describe these steps.

4.2.1 Task Array by Rating

As soon as the decision had been reached that geometric means were to be used as the scaling parameter, all tasks were arrayed on a geometric mean scale. Figure 4.2-1 shows the array. It had been expected that the ratings would yield a distribution with variability sufficient for discriminating the relative "automatability" of tasks. Such a characteristic was obtained. Further, as Figure 4.2-1 shows, tasks tended toward subsets in the distribution. These subdivisions resulted in some intervals with few or no members. Since confidence could be placed in the relative locations of tasks falling in subsets above and below these empty points, these holes in the distribution gave good indication of convenient bounds for automation levels.

4.2.2 Comparison With Present ATC Automation Level

It has been pointed out that the functional analysis done earlier in this project is generic. No particular system approach or automation level is embodied in the functions, subfunctions, and tasks in that analysis. But specific expressions of functional and task concepts, such as the present-day ATC system, can be compared with the generic description.

As a check on the validity of the raters' judgments at the task level, a comparison was made to determine what AATMS tasks could be found to be automated now in the ATC system. The comparison was done independently, after the rating data had been processed. The object was to determine whether raters had assigned high scores, indicating relative amenability to automation, to those tasks which are in fact presently automated. Table 4.2-1 shows the results. Of the twenty-two cases compared, all but two had been given high scores by the raters in relation to other tasks. One exception is Task 13.3.1 "Transfer Responsibility for Control", which is part of the ARTS III automated hand-off configuration. The other, Task 17.1.6 "Transmit Weather Observation Report", is automated in some cases and manual in others in today's system.

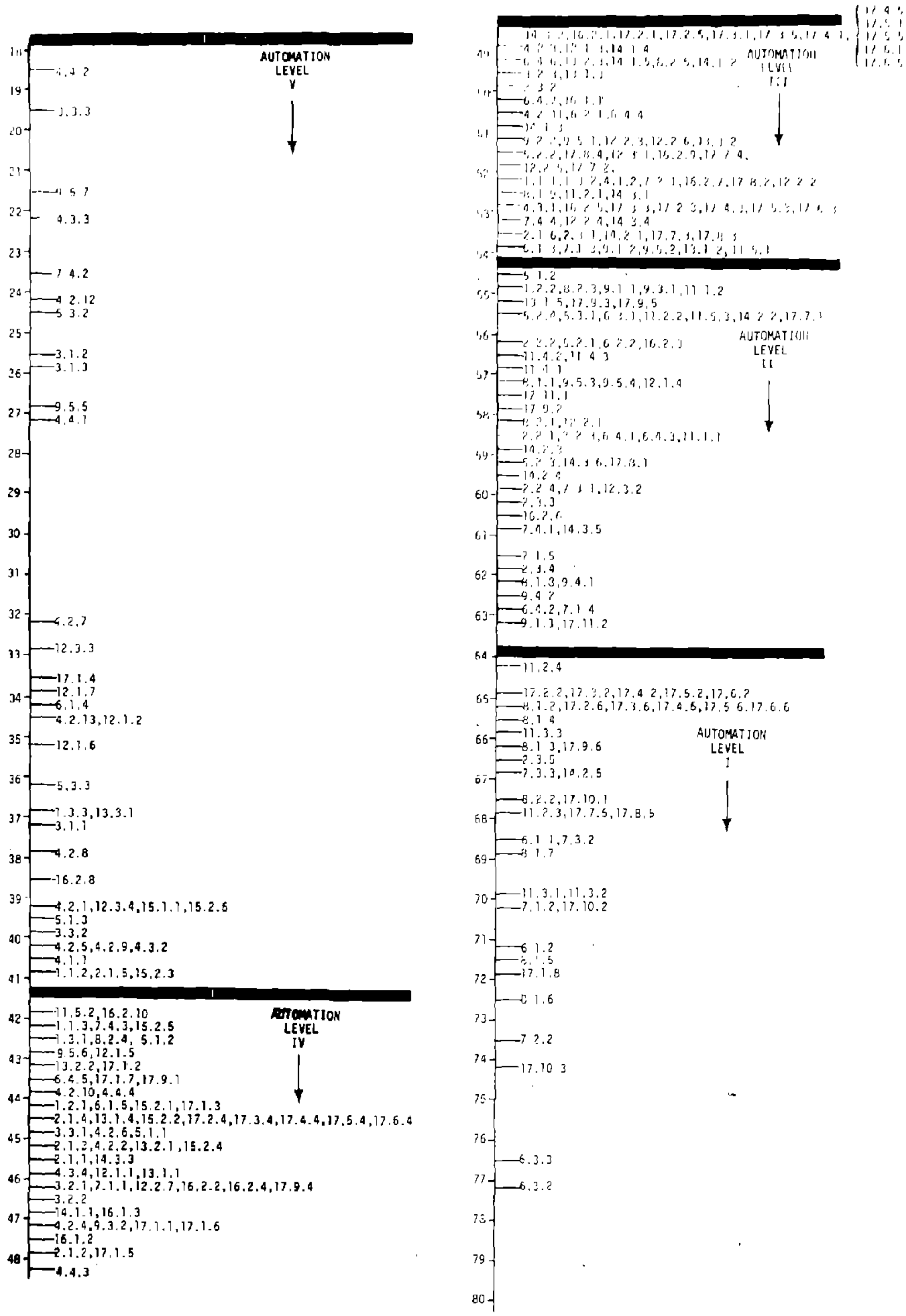

Figure 4.2-1 Automation Level Boundaries

TABLE 4.2-1 TASKS PRESENTLY AUTOMATED IN NAS/ARTS III

TASK NUMBER	TITLE	AUTOMATION INDEX	AATMS AUTOMATION LEVEL
2.2.1	Determine Jurisdiction/Terminal Demand Due to Commercial Schedules	58.5	II
2.2.2	Process and Store Reservations	56.2	II
2.2.3	Determine Jurisdiction/Terminal Demand Due to Reservations	58.5	II
2.2.4	Determine Total Jurisdiction/Terminal Demand	62.6	II
2.3.1	Compare Capacity with Demand	53.6	III
2.3.2	Determine Origins of Demand in Capacity Overload Situations	49.9	III
2.3.3	Determine What Number of Aircraft are to be Delayed for What Period of Time	60.2	II
2.3.4	Determine Where Delays are to be Absorbed	62.0	II
2.3.5	Formulate Flow Control Directives	66.5	I
6.1.1	Receive/Enter Correlated Position and Identification	68.6	I
6.3.1	Derive Rate of Change of Position	55.5	II
6.3.2	Compute Short-Range Extrapolations	77.3	I
6.4.2	Detect Aircraft Emergencies	62.8	II
8.1.2	Predict Aircraft Paths	65.2	I
9.1.1	Determine Identity and ETA of Arriving Aircraft	55.0	II
9.1.2	Determine Identity and ETD of Departing Aircraft	53.7	III
9.1.3	List Arriving and Departing Aircraft and ETA/ETD	63.3	II
13.3.1	Transfer Responsibility for Control	36.7	V
13.3.2	Compile Required Information for Clearance Function	51.3	III
17.1.6	Transmit Weather Observation Report	47.3	IV
17.7.1	Monitor COMM and NAV Systems for Status Change	55.4	II
17.7.2	Activate Standby Equipment	51.8	III

The close correspondence between rater judgments as to the relative amenability of AATMS tasks to automation and the actual state (manual or automated) of comparable tasks in the present-day ATC system gives support to the position that the rater judgments form a valid basis for deriving descriptions of successively higher AATMS automation levels.

4.2.3 AATMS Automation Level Boundaries

Figure 4.2-1 shows the AATMS tasks arrayed on a rating scale, with four boundaries specifying five levels of automation in place. The lowest automation level boundary separates those tasks that are most amenable to automation and some of those tasks that are now automated. The highest automation level boundary separates those tasks rated least amenable to automation and also those "suspect" tasks described in 4.1.2 above. The effect of the location of these outer boundaries is to isolate the two tails of the distribution of tasks. All boundaries were located by following the rule that interstices between task subsets are the most logical points to make preliminary choices.

The large group of tasks remaining within the distribution were divided into three subsets by locating boundaries at two gaps that appear in the distribution on the rating scale. Thus, as the figure shows, five levels of automation were described, replacing the continuous scale of automatability with five discrete groups of tasks. Tasks within one level were, for the purposes of preliminary analysis, considered equally automatable.

4.2.4 AATMS Automation Level Descriptions

With automation level boundaries in place, the entire array of AATMS tasks became five separable subsets. By considering each task in light of its automation level and its logical position within the AATMS functional flow, it was possible to examine the implications of each automation level from the subfunction, function, and system viewpoints. The discussion that follows is based on such an examination.

4.2.4.1 AATMS Automation Level I - Computational Aid

Automation level I (the lowest order automation level) includes 39 AATMS tasks, of which four are presently automated in the ATC system. No entire AATMS function is included at level I. Indeed, many functions are not represented at all. With the exception of one task in Function 2, Flow Control, no task from Functions 1 through 5 appears at level I, nor are Functions 9, 12, 13, 15 and 16 represented in the task subset bounded at level I. The functions absent from level I are:

1.0 Provide Flight Planning Information

2.0 Control Traffic Flow*

3.0 Prepare Flight Plan

4.0 Process Flight Plans

5.0 Issue Clearances and Clearance Changes

9.0 Control Spacing of Aircraft

12.0 Issue Flight Advisories and Instruction

13.0 Handoff

15.0 Provide Ancillary and Special Services

16.0 Provide Emergency Services

The indication is that, at this lowest-order level of automation, the tasks in these functions (with the exception noted in flow control) are all relatively less amenable to automation than those from other functions which are represented in level I. The tasks which do appear in level I are from:

6.0 Monitor Aircraft Progress

7.0 Maintain Conformance With Flight Plan

8.0 Assure Separation of Aircraft

11.0 Provide Aircraft Guidance

14.0 Maintain System Records

17.0 Maintain System Capability and Status Information

The majority of these tasks (25 of the 30 level I tasks) are from "active control" AATMS functions like 6, 7, 8 and 11. The remainder come from "records-keeping" functions 14 and 17. Two subfunctions, vector computations in Function 11 and traffic summaries preparation in Function 17, are automated at level I.

*Except for one task, 2.3.5, Formulate Flow Control Directives

Most of the tasks related to active control of aircraft that are allocated to automated means at level I involve aids to control. For example in Function 6, Monitor Aircraft Progress, such tasks as 6.1.2, Receive/Enter Position, and 6.3.3, Compute Long-Range Deviations, appear. In Function 7, Maintain Conformance With Flight Plan, 7.1.2, Construct Pairs of Flight Plans to be Compared, 7.2.2, Compute Deviations Between Aircraft's Intended and Actual Present Position, and 7.3.3, Compute Long-Rnage Deviations (in t) from Flight Plan, appear. Similarly, the tasks from Function 11, Provide Aircraft Guidance, that are found in automation level I include 11.2.3, Compute Ground Speed, and 11.3.2, Compute Vertical Speed.

Tasks describing computational aid in Function 8, Assure Separation of Aircraft are also found in level I. This includes most of the tasks involved in conflict prediction, like 8.1.5, Determine Conflict Probability for Each Pair and 8.1.6, Determine Conflict Imminence for Each Pair. Also included among tasks whose ratings fell within the level I boundary is 8.1.7, Determine Action Required. (It should be noted, however, that conflict resolution falls mostly in higher automation levels. The only task from that subfunction, 8.2 Resolve Conflicts, represented at level I is 8.2.2, Analyze Performance Changes for Conflict.)

The remainder of the tasks in level I are largely those related to data storage and manipulation in functions not involving active control. One task from Function 14, Maintain System Records, appears at level I: 14.2.5, Enter Data Element Into Storage. Such tasks from Function 17, Maintain System Capability and Status Information, as 17.1.8, Store Weather Information, 17.2.2, Retrieve Affected Data Base Item, and 17.8.5, Store Data Base Item, characterize this automation level with respect to records-keeping.

4.2.4.2 AATMS Automation Level II - Aids to Decision Making

Automation level II contains 58 AATMS tasks, of which 11 are automated in the present-day ATC system. (Levels I and II combined account for a total of 15 of 22 cases of present-day ATC automation of AATMS generic tasks.) While no entire AATMS function is yet automated at level II, five sub-functions are automated at this level as compared to two at level I.

Many more AATMS functions appear in automation level II than appear in level I, but some are still absent from both level I and level II. These are:

Function 1.0, Provide Flight Planning Information (except for one task in level II)

Function 3.0, Prepare Flight Plan

Function 4.0, Process Flight Plan

Function 13.0, Handoff (except for one task in level II)

Function 15.0, Provide Ancillary and Special Services

All the remaining AATMS functions are represented in the level II task subset by two or more tasks. As is the case at level I, those AATMS tasks related to active control of aircraft make up a large part of the level II subset. Some of these tasks extend the theme of automating computations to aid control, as in level I. Others, however, introduce another kind of aid. These include tasks in Function 6.0, Monitor Aircraft Progress, like 6.4.1, Determine Aircraft Readiness, and 6.4.3, Determine Nature of Emergency. At AATMS automation level II, such tasks in Function 7.0, Maintain Conformance with Flight Plan, 7.1.5, Propose Revised Flight Plan to Correct Long-Term Conflicts Among Flight Plans, and 7.4.1, Compare Deviations with Tolerances are found. Separation assurance, Function 8.0, is represented at level II by tasks such as 8.1.8, Monitor for Unexpected Deviations, and 8.2.1, Hypothesize Performance Changes.

In Function 11, Provide Aircraft Guidance, the computation of vector components begun in level I is extended to include computation of guidance commands themselves, Subfunction 11.4. Level II thus contains tasks which, if automated, would provide aids to decision-making as well as computational aids in these AATMS functional areas.

Automation level II marks the first appearance of tasks from Function 9, Control Spacing of Aircraft, and Function 16, Provide Emergency Services. Function 9 is represented by tasks like 9.3.1, Analyze Temporal Distribution of Arrivals and Departures, and 9.5.3, Check Proposed Performance Change for Predicted Conflict. Two function 16 tasks fall in level II. They are 16.2.3, Determine Aircraft to Provide Assistance, and 16.2.6, Determine Emergency Flight Plan.

Another AATMS function which first appears at automation level II is Function 12, Provide Flight Advisories and Instructions. While this function is not necessarily one of control itself, it is more directly related to active control than are the records-keeping functions, 14 and 17. Three tasks from Function 14 appear at level II; three tasks from function 12 appear, including tasks 12.1.4, Retrieve Information Requested, 12.2.1, Evaluate Advisory for Data Content, and 12.3.2, Compile Alert Message.

While automation level II does not yet encompass flight planning or flight plan processing, some other functions that are carried out prior to flight are represented. In particular, Function 2 (flow control) appears in level II, with seven tasks out of a total of fifteen in the function represented at this level. (It should also be noted that of the eleven cases of correspondence at automation level II with tasks presently automated in the ATC system, 6 relate to flow control as an activity.)

The remainder of the AATMS tasks in automation level II are related to records-keeping. Function 14, Maintain System Records, has tasks like 14.2.3, Determine if Data Transform/Reformat is Required, and 14.3.6, Compile Report, at level II. Function 17, Maintain System Capabilities and Status Information is represented at level II by tasks like 17.8.1, Monitor Ground Facilities for Status Change, and 17.9.5, Format User Class Data Base Item.

4.2.4.3 <u>AATMS Automation Level III - Decision Making</u>

Automation Level III includes 71 AATMS tasks. Five of these are found to be automated in today's ATC system; twenty of the twenty-two cases are automated when levels I, II, and III are taken cumulatively.

The cumulative affect on AATMS is also significant by the time automation level III is reached. Again, no entire function is included as yet, but at this level, sixteen complete subfunctions fall entirely into the automated category.

In the "active control" area, this automated category includes subfunctions like 6.2, Compile Aircraft Time-Position Profile, 7.2, Determine Current Deviations From Flight Plan, 8.1, Predict Conflicts, and 9.1, Maintain Predicted Arrival/Departure Schedule for Each Airport.

Such "records-keeping" subfunctions as 14.2, Compile and Store System Records, 17.7, Determine Capability and Status of COMM-NAV System, and 17.8, Determine Capability and Status of Ground Facilities are entirely automated when levels I, II, and III are taken together, and activities prior to flight like 2.3, Determine and Resolve Capacity Overload Situations, and 5.2, Determine Clearance to be Issued, are also judged as automatable.

At the task level, the nature of automated activities begins to include decision-making itself, as well as aids to decision and computational aids. Examples include 2.1.6, Determine Total Effect on Capacity, 5.2.2, Determine Clearance Tolerances, 9.5.1, Select Sequence/Schedule Change to be Implemented, or 12.1.3, Select Applicable Preformatted Messages.

Aids to decisions involved at this level represent some higher-order analysis and synthesis than that found earlier. Tasks like 4.2.3, Probe for Conflicts Among Flight Plans, 9.5.2, Hypothesize Performance Change Required to Implement Required Sequence/Schedule, 13.1.3, Correlate Aircraft Position with Airspace Structure Boundaries, 14.1.4, Determine Necessity for Additional Information, and 17.2.5, Format New Data Base Item, illustrate level III decision aids.

More than half of the 71 tasks in level III are concerned with decision-making and decision aiding. About one-fourth of the tasks at this level relate to "records-keeping" and the remainder are concerned with receipt, entry, or retrieval of information.

4.2.4.4 AATMS Automation Level IV - Automated Communications

Fifty-nine AATMS tasks are included in the subset between level III and the upper bound of level IV. The functional impact of the addition of these fifty-nine to those which fall below level IV is that three entire AATMS functions are now automated. They are:

Function 8.0, Assure Aircraft Separation

Function 11.0, Provide Aircraft Guidance

Function 14.0, Maintain System Records

Several other functions at level IV are close to complete "automation." For example, only one manual task remains in Function 17.0. The same is true for Function 13.0, Handoff*, Function 9.0, Control Spacing of Aircraft, Function 7.0, Maintain Comformance With Flight Plan, Function 6.0, Monitor Aircraft Progress, and Function 2.0, Flow Control.

The same trend with respect to automatability at higher-order levels of decision-making and decision aiding tasks that was discussed earlier continues at level IV. Nearly half of the fifty-nine tasks are in these categories.

Of the remainder, most tasks are higher-order data manipulation; for example, Function 17.0 accounts for thirteen tasks at this level.

A relatively small number of tasks, however, make a significant contribution to the character of the effects of automation on AATMS at level IV. These are the tasks involving transmittal to, or receipt of information from the pilot, like 7.4.3, Receive Pilot's Response Concerning Resolution of Out-of-Tolerance Present and/or Long-Range Deviations, 8.2.4, Transmit Performance Change Message to Pilot, 11.5.2, Transmit Vectoring Instructions to Pilot, and 13.1.4, Receive Pilot's Request for Transfer of Responsibility.

4.2.4.5 AATMS Automation Level V - Full Automation

The highest order AATMS automation level contains 38 tasks. These fall in that subset adjudged by the raters to be, in relation to all other AATMS tasks, least amenable to automation**.

Task that fall in this category are ones like:

1.1.2 Accept Telephone Request

3.1.2 Specify Aircraft and Pilot Information

4.2.8 Compile List of Discrepancies

5.1.3 Determine Pilot Intentions Following Missed Approach

9.5.5 Submit Performance Changes Within Existing Flight Plan to Clearance Function

12.1.7 Transmit Special Response to Pilot

*This is the "transfer responsibility for control" task mentioned earlier.

**The subset also contains many of the "suspect" tasks discussed in 4.1.2 earlier.

13.3.1 Transfer Responsibility for Control

16.2.8 Inform Pilot of Change to Emergency Frequency Link

17.1.4 Receive Supplemental Data

Of the 38 tasks, more than half are concerned with some sort of interaction between the files and the system, for example, 1.1.2, Accept Telephone Request, and 7.4.2, Inform Pilot of Out-Of-Tolerance Deviations. This placement of these kinds of tasks continues the pattern first visible at level IV. The remainder, while not descriptive of AATMS/user interface activities, does involve a level of complexity which in the judgment of the raters, placed them in this last subdivision of automatability.

4.2.5 AATMS Automation Levels by Function

Table 4.2-2 shows the percentage of tasks in each AATMS function that would be automated at each of the five automation levels.

The table illustrates the point that the nature of the tasks, as seen by the raters, differs markedly from function to function. The effect is that automation reaches some functions, for example, 7, 8, 11, at lower levels than others, for example, 2, 4, 16.

A second effect shown in the table is that the size of the automation increment from one automation level to the next higher level also differs markedly from function to function. For example, in Function 2, the percent difference between Level I and II is 40, while Function 1 has only a 13 percent change between the same two automation levels.

It should be noted that these two effects stem mainly from the manner in which the raters placed the tasks along the automation continuum, i.e., the effects would persist if the automation level boundary locations were different than those chosen for this discussion.

TABLE 4.2-2 PERCENT AUTOMATION BY FUNCTION AND AUTOMATION LEVEL

FUNCTION	PERCENT AUTOMATED AUTOMATION LEVEL				
	I COMPUTATION AID	II DECISION AID	III DECISION MAKING	IV COMMUNICATION	V FULL AUTOMATION
1.0 Provide Flight Planning Information	0	13	38	75	100
2.0 Control Traffic Flow	7	47	67	93	100
3.0 Develop Preliminary Flight Plan	0	0	11	44	100
4.0 Process Flight Plan	0	0	17	48	100
5.0 Issue Clearances and Clearance Changes	0	50	60	70	100
6.0 Monitor Flight Progress	24	53	82	94	100
7.0 Maintain Conformance with Flight Plan	29	57	79	93	100
8.0 Assure Separation of Aircraft	50	79	93	100	100
9.0 Control Spacing of Aircraft	0	47	75	88	100
11.0 Provide Aircraft Guidance	31	81	94	100	100
12.0 Issue Flight Advisories and Instructions	0	17	56	72	100
13.0 Handoff	0	10	50	90	100
14.0 Maintain System Records	6	38	88	100	100
15.0 Provide Ancillary and Special Services	0	0	0	63	100
16.0 Provide Emergency Services	0	15	54	92	100
17.0 Maintain System Capability and Status Information	29	41	76	98	100
All Functions	15	37	64	86	100

5.0 CONCLUSIONS

The discussion which follows is confined to two specific areas, the task allocation methodology and its application in derivation of system automation requirements. The broader ramifications of automation levels and their relationship to system design and evolution are treated elsewhere in this report. In Volume I, Chapter 4, the reader will find a general discussion of the implications of automation in an advanced air traffic management system, wherein the questions of automation benefits, system characteristics, configuration development, and system evaluation are addressed. Volume IV of this report contains a detailed exposition of the recommended level of automation and specific analyses of automation requirements which derive from this recommendation. The conclusions which follow, therefore, pertain only to the man-machine allocation methodology and its usefulness as a basis for subsequent system analysis and specification of design requirements.

5.1 METHODOLOGICAL IMPLICATIONS

One of the problems faced by the designer of a complex man-machine system is how to make effective use of previous research. Broadly speaking, research can be of two kinds: that directed toward supporting the design of a specific system and that addressed to some general problem. From the designer's viewpoint, neither is wholly satisfactory. Research carried out in designing one system may be too narrow in focus or too specific to be adapted to fit another system. On the other hand, research of a general nature tends to treat problems at an abstract level and often in a fragmentary way, with the result that the system designer is left with uncertainty about its relevance or implications for the task at hand. Bear in mind also that the designer, unlike the researcher, is not looking for universality; he is seeking a solution to a specific design problem. Thus, he seldom asks how things are in general, but how they should be in this particular case. This is to say that the designer is practically oriented; he is not so much concerned with principles as with their application.

The man-machine allocation methodology developed for this study was intended to cope directly with the problem of bridging the gap between principles and application. The aim was to devise an explicit procedure by which criteria could be applied to make decisions about the assignment of tasks to human or automated resources. To put it another way, the objective was to go beyond the usual collation of research findings and design principles and to give the system engineer a clearly defined and objective method for applying these rules to the question of man-machine allocation in AATMS.

The approach involved construction of a quantitative and objectively derived rating scale of task automatability, called the Automation Index. The foundation of the Automation Index was an analysis of air traffic control operations, carried out to a level of detail where each unit of activity (task) was allocatable as a whole to man or machine resources. The Automation Index itself was a multi-dimensional scale made up of a set of performance characteristics extracted from the research literature on man and machine capabilities. The fundamental assumption was that, while men and machines have certain basic capabilities in common, the manner in which they manifest these capabilities and the characteristics of performance are different. These performance differences formed dimensions which could be used to rate the suitability of man and machine resources for carrying out task assignments. It is important to note that the rating process did not involve a direct judgment about automation <u>per se</u>, but rather a matching of task requirements and the performance characteristics of resources which might be assigned to the task. Putting the question in this form served both to minimize the influence of preconceptions about automation and to focus attention on the evaluation of resource capabilities in light of task requirements.

From a practical point of view, the task allocation methodology proved to be a success. The rating process required about three man-days of effort by each rater, but considering the number of individual judgments to be made (about 770 by each participant) and the voluminous task descriptions which had to be studied, this was not an inordinate investment of time. Rater compliance was exceptionally high; in fewer than 2% of the cases did raters decline to make a rating of a task-capability combination. Ratio scaling, although unfamiliar to the participants, proved to be an acceptable and convenient technique, once understood. The raw data from the ratings, since they were expressed in numerical form, lent themselves readily to machine processing using simple, standard statistical routines.

Analysis of the findings indicated that the aggregation of rating scores produced an Automation Index of high validity and internal consistency. Interrater agreement, as tested by the Spearman-Brown reliability coefficient, was 0.822 in a circumstance where a value greater than 0.60 would be considered acceptable. Additional tests of the rating results by standard analysis of variance revealed that there was no discernible rater bias attributable either to occupational specialty or group affiliation. The internal variability of task Automation Indices, due either to lack of consensus among raters or inconsistency of ratings across performance capabilities within given tasks, was generally low. Over 80% of the task indices, when tested by four separate statistical confidence measures, proved to be reliable. The variability of the remaining task indices (52 of a total of 265) turned out to be a useful symptom for identifying areas of controversy about automation and for isolating conceptual and procedural problems in the task descriptions and the rating protocol. In other words, there was a built-in quality control element in the rating procedure.

Apart from internal statistical reliability, the task rankings by Automation Index also exhibited a gratifying validity when tested by external criteria. One such test was a comparison with the present ATC system. An examination was made of 22 generic AATMS tasks which could be closely identified with tasks presently automated in the NAS Stage A and ARTS III system. The Automation Indices for 20 of these tasks indicated that the raters also considered them highly suitable for automation. Thus, taking the existing system as a standard, the Automation Index produced task allocations that were highly consistent with the engineering judgment which led to the automation of these tasks in NAS Stage A and ARTS III.

A second, and perhaps more significant, indication of the external validity of the findings was found by examing the common characteristics of tasks which lay within any given level of automation. Tasks which, on logical grounds, had common performance requirements or functional similarity tended also to have equivalent Automation Indices. This finding suggests strongly that raters, regardless of their background and experience and despite any general bias they may have had about automation, were inclined to have a highly uniform and logically consistent view of performance requirements in relation to tasks. Thus, it seems legitimate to conclude that the rating process did, in fact, tap an underlying and common conception of resource-task compatibility.

To summarize, the positive features of the Automation Index methodology appear to outweigh its disadvantages. The method is conceptually simple and practical to use. In comparison with other methods for determining man-machine task allocation, it is rapid and fairly economical of manpower. The resulting rater estimates, because they are expressed in numerical form, are readily processed by machines and simple to manipulate mathematically. The Automation Index, derived by straightforward computational techniques, is both statistically reliable and logically coherent. The method is easy to replicate and verify. And, highly important, the method yields pertinent and detailed answers with regard to assignment of tasks to human and automated resources. There are some negative attributes. The method calls for a high level of rater cooperation. Extensive task analysis and preparation of the rating protocol are required before the rating process can begin. The results, because they are expressed as numbers, are subject to possible misinterpretation and even abuse. That is, the task rankings are valid only as relative indices of automatability, yet they are prone to interpretation in an absolute sense by those not fully conversant with the method and the rationale of the rating procedure. However, as stated above, these disadvantages are far from overwhelming, and there appears to be much more on the positive side of the ledger.

5.2 APPLICATIONS OF THE AUTOMATION INDEX

The immediate application of the Automation Index was to provide a direct (albeit tentative) answer to the question of man-machine task allocation. However, the Automation Index also had several other important uses in the latter stages of the AATMS study, where the objective was to determine system requirements arising from the recommended level of automation. An analysis of these requirements is provided in Volume IV of this report and will not be repeated here. However, in the interest of providing a full picture of the utility of the Automation Index methodology, it is appropriate to append here a brief discussion of its subsequent applications in the AATMS study.

The Automation Index provided a relative ranking of tasks according to their suitability for automation. This formed the basis for subdividing the entire functional array into incremental steps or levels, progressing from a wholly manual system concept to one which was fully automated. This, in turn, provided the structure for the analysis of the man and machine resources required to operate the system and the selection of a recommended automation level which offered an optimum balance of men and machines. Without the help of the Automation Index in defining suitable groups of tasks to transfer successively from human to automated resources, the number of permutations and combinations to be considered in the exercise would have been unmanageably large. Thus, the Automation Index served to determine not only the order in which tasks should be considered for automation but also the size and specific composition of the increments which were to be used in the resource requirements analysis.

A second, and equally significant, use of the Automation Index was its application in the analysis of failure modes requirements. In the event of system failure (i.e., the loss of some automated resource), one possible form of response would be reversion to a manual mode of operation. To assess the appropriateness of this response, it was necessary to determine the suitability of man to perform the tasks carried out by machines in the normal operating state of the system. The Automation Index provided a valuable form of evidence in making this determination. That is, if the candidate tasks had Automation Indices reflecting man-like performance requirements, this was taken as a sign that manual back-up in failure modes was, at least, feasible. Other factors (notably the frequency of task performance and the estimated time to perform the task manually) were also taken into consideration in the final determination, but the suitability for manual performance as expressed by the Automation Index was taken as the necessary first condition.

Another application of Automation Index was in the analysis of control and display requirements. The starting point for this analysis was a detailed definition of the man-machine interface. This meant systematically locating each point in the functional array at which a manual task followed an automated task or vice versa. The Automation Index made this exercise possible because it provided a precise indication, at the task level, of which activities were assigned to man and to machines for any given degree of system automation.

Beyond these specific applications in deriving end products of the study, the Automation Index methodology also offers useful information at two more general levels. First, it provides a basis for sorting the task allocations as to level of confidence. Be segregating those tasks where the indices are firm from those of questionable reliability, additional research can be focussed sharply on the real problem areas. For example, the method makes it possible to isolate a subset of tasks which have been inadequately or ambiguously defined and so to pinpoint defects in the functional analysis. Similarly, it is also possible to label some tasks as controversial and, thereby, to earmark them for more intensive analysis by a different mode of study such as simulation or operational testing. At a second and still more general level, the Automation Index provides a valuable common denominator to structure and facilitate the comparison of alternative design concepts. This application alone may, in the long run, prove to be the most useful methodological contribution arising from this study. By lifting the evaluation of alternative designs, at the concept stage, out of the realm of speculation and placing it on an objective and quantitative basis, the Automation Index will give the designer an early and detailed view of the practical consequences of any given scheme of man-machine task allocation.

It would be remiss to conclude this survey of applications without setting in proper perspective the value of the Automation Index as a design tool. The Automation Index is not to be viewed as a substitute for engineering judgment, which traditionally has been and certainly will continue to be the mainstay of system design. The allocation of tasks to men and machines on the basis of the Automation Index must be considered tentative at this point. It will have to be tested, confirmed, and refined by interplay with factors like safety, capacity, and cost. For any configuration thus evolved, the role of man in the system will require further exploration -- man must be able to manage the system, users must accept the configuration, controllers must be able to alter their behavior in failure modes to achieve fail-operational or fail-safe performance. Engineering judgment, simulation, and all the other tools in the system designer's repertoire will be needed.

As a result of the present study, however, there is now a design aid not previously available. The universe of functions and tasks has been derived and defined in a way which is independent of equipment considerations. Further, the array of tasks has been ordered by means of the Automation Index according to the relative capabilities and performance characteristics of men and machines. Thus, the system designer has at his disposal a new method, allowing him to make an initial estimate of automation priorities which is at the same time relevant to a system concept and exempt from innate bias toward means. The Automation Index methodology, therefore, should be viewed not as a mechanistic replacement for engineering judgment but as a new and more systematic way for exercising engineering judgment in the design process.

APPENDIX A

SUMMARY OF MAN AND MACHINE PERFORMANCE CAPABILITIES

This appendix contains extracts from the research literature on man and machine performance capabilities. The citations are grouped under seven categories of performance:

- Monitoring
- Sensing
- Information Processing
- Interpreting
- Decision Making
- Storing and Retrieving Information
- Responding

Within each category, statements are presented under three headings:

- Human Capabilities and Limitations
- Machine Capabilities and Limitations
- Man-Machine Performance Comparisons

Each statement is referenced to the bibliography provided at the end of this appendix.

MONITORING

Human Capabilities and Limitations

By being alert for changes, human beings can frequently anticipate undesirable conditions. ref. 5

Man can function very effectively as a monitor of complex systems if given proper information and displays. ref. 9

If man is already present in a given situation, it may be more economical to use him as a monitor than to provide additional equipment, provided the monitoring tasks are properly designed to compensate for man's limited capabilities. ref. 28

If man is to serve as an emergency backup (to automatic monitoring equipment), it may be necessary to assign manual tasks which could be better performed by machine, simply to keep the man aware of what is happening in the system. ref. 23

If signals must be detected in high noise environments, then it may be desirable to use man for monitoring. In operational situations, this applies mostly to cathode-ray tube displays such as radar displays, auditory equipment, and external communications equipment. In maintenance situations, this capability is most relevant in the use of test oscilloscopes. ref. 28

Although many machines are made completely automatic, men often should be used to override the machine to meet emergencies or situations requiring judgments for which the machine has not been programmed...Also, in the event of a failure or other emergency, the man could override the automatic controls. ref. 16

Detection of low energy signals in a random signal background appears easier via sound than visually. Combined inputs (sound and visual) indicated some performance improvements. ref. 16

In addition to his unsuitability for the detection of electromechanical energies per se, man is typically a poor monitor of infrequently occurring events or events occurring over long periods of time. He is easily distracted and he may become bored or fatigued. ref. 28

Man is an unreliable monitor. The more passive his role in a system the more he tends to withdraw from the system by letting his attention wander or even by going to sleep. If it is desirable that man serve as an emergency backup, then he should be given tasks to keep him aware of what is happening in the system so that he can take over when needed. It may be necessary to give him these tasks even though they could better be done by a machine. ref. 23

Human performance when monitoring displays for signals that occur very rarely is generally unreliable. ref. 26

In general, performance in monitoring extremely low-frequency events deteriorates over time, and a number of relevant variables have been identified. Among the most prominent are signal characteristics: frequency, regularity, size, intensity, and spatial distribution; and task variables: spacing of rest periods, level of extraneous noise (visual and auditory), presence of other stimuli, and schedule of reinforcement for observing responses. ref. 26

The human operator should not be assigned monitoring tasks that require continuous attention to a display unless absolutely necessary. ref. 26

One shortcoming (of human montoring ability) is the human tendency to fill in gaps in the displayed information on the basis of expectancies. When these expectancies are not valid, the technician may see something that is not there, or may miss out-of-tolerance indications not in line with his erroneous expectancy. ref. 16

Machine Capabilities and Limitations

If at all possible, the computer rather than a man should have primary responsibility for maintaining vigilance and detecting when, after period of inactivity, some system action is required. ref. 4

Machines generally are better in their abilities to monitor for prespecified events, especially when infrequent (but machines cannot improvise in case of unanticipated types of events). ref. 15

Humans are relatively poor, with respect to machines, for monitoring other men or machines. ref. 27

Where possible, equipment should be designed to monitor men and stop, or give a warning, whenever operators make mistakes. ref. 16

Long-term monitoring of specific physical energies generally should be performed by equipment sensors. ref. 28

If the unpredictability of the signal makes it difficult or impossible to use an equipment sensor, then it may be necessary to use man. For example, the visual and auditory capabilities of man may be useful when it cannot be predicted:

(1) Where the signal will occur, although some notion may be had of when it will occur;

(2) When the time of onset will be, although the position in space of the signal is predictable;

(3) Whether something is going to occur. ref. 28

The computer should have primary 'responsibility' for vigilance and detection functions following periods of inaction whenever possible. ref. 26

Man-Machine Performance Comparisons

MAN	MACHINE	
Man can monitor low-probability events for which, because of the number possible, automatic systems would not be feasible.	Program complexity and alternatives of machines are limited so that unexpected events cannot be adequately handled.	ref. 10
Men are poor monitors of infrequent events or of events which occur frequently over a long period of time.	Machines can be constructed to detect reliability in events which occur frequently over a long period of time.	ref. 19
Man can detect masked signals effectively in an overlapping noise spectrum on displays such as radar and sonar.	Machines are not very good at detecting signal in noise when spectra overlap.	ref. 10

SENSING

Human Capabilities and Limitations

The human sensing capacities of vision and audition generally surpass those of machines. ref. 5

Man senses many stimuli at once and will therefore select, from a variety of responses available to him, one which is more or less appropriate to the situation. ref. 5

The ability to detect certain forms of energy, especially very low energy levels which can be detected by humans, but which are not great enough to activate an instrument, is one of man's characteristics. ref. 24

Man has excellent signal detection ability and his real-time capacities can be used in sensor systems such as radar, sonar and infrared; however this usually is one of the least desirable uses of men in systems. ref. 9

Human beings are usually superior to machines in perceiving and interpreting sensory information. ref. 31

Since man is essentially a single-channel receiver, the simultaneous use of more than one channel should generally be avoided. ref. 26

Detection of low energy signals in a random signal background appears easier via sound than visually. Combined inputs (sound and visual) indicate some performance improvement. ref. 31

If man is already present in a given situation, it may be more economical to use him as a sensor than to provide additional equipment if the sensing requirements are within the range of human sensitivity. This also is related to the desirability of providing a man with enough work so that he will maintain a reasonable level of motivation and alertness. ref. 28

Man's capability to use several dimensions of a given sense modality when building up sequences or "chunks" of information has great potential for increasing channel capacity. ref. 26

The capacity for absolute judgments of auditory stimuli in a single dimension (e.g., pitch) is a little over 2 bits, while that for visual stimuli varies between 2.1 and 3.1 bits. Combining two auditory dimensions increases capacity to 3.1 bits. ref. 26

Human sensing is restricted to a relatively narrow range of physical energies. Man's visual sensing is limited roughly to the wavelengths between 300 and 1,050 mμ -- an extremely small portion of the electromagnetic spectrum -- and his auditory sensing is limited roughly to the frequencies between 20 and 20,000 cps (in many people, the upper limit might be under 10,000 cps). But human sensitivity -- in the sense of the minimum energy that man can detect -- compares favorably with the sensitivity of machines. ref. 16

For the <u>sensing</u> function, the limitations of man are quite apparent. The physical-energy changes he can sense are limited to those which affect his receptors of vision, hearing, touch, smell, taste, and so on. In contrast, machines are able to sense changes beyond these limits, in the ultraviolet and infrared regions of the electromagnetic spectrum, above 200,000 cycles in the mechanical spectrum, and so on. Within the limitations of his senses, a man's sensitivity is quite good, since it is known that he can sense very small differences. But the number of changes he can respond to at one time is relatively small -- that is, his channel capacity is limited. ref. 11

Human performance is limited with regard to excessive temporal demands (e.g., rapid sequential events, overlapping signals, multichannel events, etc.), and also with respect to infrequent input occurences. ref. 26

Noise, or unwanted random signals, in the input degrades human performance seriously on a number of different types of perceptual tasks: detection of auditory and visual signals, recognition of patterns, and compensatory or pursuit tracking.... Human performance generally decreases as the period of intermittence (both for feedback and input information) is reduced. ref. 26

Man is seriously limited with respect to bandpass, channel capacity, and peak power; man is essentially a single channel computer and must accomplish multiple tasks sequentially (i.e., by means of time sharing); his great asset is his capacity for learning and adaptive processes. ref. 9

Machine Capabilities and Limitations

The function of human sensing is not used with particular frequency in modern systems, largely because machines can be designed to do a better job. ref. 11

Machines can sense forms of energy that are in bands beyond man's spectrum of sensitivity, such as infrared, radio waves, X-rays, radar wavelength and ultrasonic vibrations. ref. 15

Where values of physical energies must be quickly and accurately appraised, mechanical devices are obviously superior to men. ref. 26

Detection and discrimination of specific physical energies should be performed by equipment sensors, except for the following considerations:

a. If the situation requires the reception of many different types of physical energy in close proximity in time but not simultaneously (such as might be involved in steering a vehicle, where visual, auditory, tactual, and kinesthetic sensing all may be useful for control), the multipotentiality of man's senses may indicate his use for detection and discrimination functions.

b. If high noise levels are present, it may be necessary to utilize man to detect signals. This capability is often associated with detection of signals on cathode ray tube displays and use of communication equipment.

c. If equipment sensors cannot be designed to provide effective scanning, then it may be necessary to use man. Man, through his ability to direct his attention to various portions of his environment, may provide a more effective means of detection than more highly programmed equipment sensors.

d. If contingencies which may arise in the operation and maintenance of the system cannot be predicted adequately during its design, it may be necessary to include man as a sensor for some back-up functions. ref. 28

Man-Machine Performance Comparisons

MAN	MACHINE	
Man is a selecting mechanism and must be set to sense specific items.	Machines are sensing mechanisms.	ref. 19
Man's capability is limited to certain ranges of energy change affecting human senses. Sensitivity: very good.	The machine's range extends far beyond human senses (X-rays, infrared, etc.). Sensitivity: excellent.	ref. 11
Under favorable conditions absolute thresholds of sensitivity in various modes (visual, audition, tactile) are very low.	Machines' thresholds are generally not as low as human. They may have the same capability but only at great expense.	ref. 10
The human has limited channel capacity.	Machines may have as much channel capacity as can be afforded.	ref. 30
Not subject to jamming, EMI, etc.	Generally subject to interference by enemy action and noise.	ref. 30

INFORMATION PROCESSING

Human Capabilities and Limitations

Man is able to handle a great variety of different information processing tasks. ref. 8

Man can use raw information immediately without coding, punching or similar operations. ref. 21

Generalized information processing and decision making should be performed by personnel where:

a. Pattern perception is important (especially where patterns may change in size, position, or energy configuration (types and strength levels) under different conditions.

b. Long-term storage of information is required.

c. Insight, discovery, or heuristic problem solving is required.

d. Decision making and learning in a complex changing situation are required.

e. Ability to improvise and adopt flexible procedures is important and, within the state of the art, cannot be built into a machine program.

f. Number of low-probability events which might occur is high and the cost or capacity of machine programming is exceeded by the requirement.

g. Inductive reasoning is required, i.e., a requirement exists for generalizations to be made from the specific events. ref. 28

A major characteristic of man as a data processor is his flexibility. First, people do not require extensive or precise preprogramming. Men can deal with changing situations and unforeseen problems in the absence of a specific program. ref. 21

In the capacity of an information link, the human being has been found capable of processing about 3 bits of information per stimulus event regarding any stimulus dimension. ref. 26

Man has certain advantages and disadvantages as compared with computers. His access time (speed of recall) is slow compared to that of a computer, but he is able to recall generalized patterns of previous experience to solve immediate problems. As yet, no computer can do this. Man learns to do numerical computations, but in the main his time constants are such that he is a relatively poor numerical computer -- especially under stress. He is, however, the only available computer that can solve problems by logical induction.

In general, man is superior to data-processing devices in the following respects:

a. For most tasks, he does not need extensive preprogramming. Through further learning, he constantly develops and modified his own programs. His previous education has already "programed" him.

b. He is more flexible; he can deal with unforeseen situations.

c. He can exercise judgment because he can selectively recall relevant facts and methods of solving problems.

d. He does not require special coding of messages; the information does not have to be transformed into digital form. He does, however, perform better when information is presented in certain forms than when it is presented in others. ref. 16

Man learns to do numerical computations, but in the main his time constants are such that he is relatively poor numerical computer when under stress. No computer can match him, however, for the more qualitative, nonnumerical computations. ref. 31

In marked contrast to his limited information-handling rate is man's ability to handle a great variety of different information-processing tasks. The number of different functions which a man is capable of performing almost defies enumeration, and undoubtedly is one of his greatest assets as a system component. ref. 8

Man's data processing capability includes situations where the human acts as an encoder. Here there is a transformation of the input signals such that the response output may be either qualitatively and/or quantitatively different from the input. Cortical involvement may vary widely, depending upon the task; however, the minimum degree of involvement would usually exceed that of the relay situation. The task of keying a code number to represent address information would be an example. ref. 12

Reprogramming man's filtering conditions is a matter readily accomplished by instructions; in a machine, this would be expensive or time-consuming or both. ref. 11

The human being is limited in the amount of information he can receive and process within a given period of time. ref. 26

Humans are relatively poor, with respect to machines, for performing routine, repetitive tasks. ref. 27

Humans are relatively poor, with respect to machines for computing and handling large amounts of stored information. ref. 27

Humans are relatively poor, with respect to machines for ability to reason deductively (i.e., to use rules for processing information). ref. 27

Man is a relatively poor numerical computer under stress but is unmatched for the more qualitative nonnumerical computations. ref. 31

Man has great versatility in handling many different input and output codes; however he is a relatively slow information processor and is being replaced by machines in many clerical tasks. ref. 9

Design the man-machine system so that the bandpass required of the man never exceeds three radians per second. ref. 3

Design the man-machine system so that the transfer function required of the man is, mathematically, always as simple as possible, and, wherever practicable, no more complex than that of a simple amplifier. ref. 3

Machine Capabilities and Limitations

Specialized information processing and decision making should be performed by equipment where:

a. Deductive logic can be programmed.

b. Speed and amount of memory search or entry (storage) is an extensive requirement.

c. Highly complex computations or logical operations are involved.

d. Short-term storage and retrieval of large amounts of data is required.

e. System functioning requires extremely short time lags between scheduled events.

f. Many routines, channels, and memory areas must be utilized simultaneously (parallel operation).

g. A high degree of repetitiveness and routine is involved in the sequence of tasks or events.

h. Events are unambiguous and probable but can be expected to occur only infrequently, e.g., as in monitoring of equipment readiness.

i. Reduction of the over-all amount of work load and activity for personnel can be expected and provided within system cost parameters. ref. 28

Any high-volume information-processing task in which the rules for processing are simple and easy is just right for machine performance. And tasks which are not of this nature can often be made so by appropriate redefinition. ref. 4

Machines are capable of handling highly complex operations (i.e., doing many different things at once). ref. 24

Machines excel in ability to repeat operations very rapidly, continuously, and precisely the same way over a long period. ref. 31

Computers, while not perfectly reliable, make fewer errors than men and often can detect their errors. They also can be more precise, performing more difficult procedures without extra cost, and when they can perform otherwise impossible computations, they may reduce the cost of operation. ref. 26

Data-processing devices are superior, in general, to human beings in the following respects:

a. They can store much more data accurately. A computer can store thousands of items of information that no human being could possibly remember.

b. They can compute answers with much greater speed and accuracy. A computer can do accurately, in a few seconds, computations that would otherwise require many man-months.

c. They can sort and screen data faster, rejecting all data that are not in a desired class and leaving the final judgment among the remaining alternatives to a human operator.

d. They are usually more reliable for routine decisions -- decisions that are always made in the same way according to some rule.

e. They are less subject to fatigue, prejudice, and other transitory factors that distort man's judgments and decisions. ref. 16

Machines designed to perform specific computing operations are more efficient than man. ref. 5

Machines generally are better in their ability to count or measure physical quantities. ref. 15

Machines generally are better in their ability to process quantitative information following specific programs. ref. 15

Machines excel in performing complex and rapid computation with high accuracy. ref. 31

Machines are much quicker and more reliable than humans in identifying a specific item as belonging to a large inclusive class and in using rules for processing information. If the test and checkout operation can be programmed 100%, then a machine can be built to perform the operation rapidly and accurately with perfect repeatability. However, and this is often overlooked, procedures can be built to enable the human to follow the rules efficiently, though less rapidly and with a small but finite probability of error. ref. 24

Man-Machine Performance Comparisons

MAN	MACHINE	
Speed of reinstatement of rule sequences relatively low (as in computing).	Speed of using rule sequences high (e.g., computing).	ref. 11
Limits to length of sequential routines fairly high, but time-consuming to train.	Potential limits of length of routines very high.	ref. 11
Easy to reprogram, does not require extensive or precise **preprogramming**.	Difficult to reprogram.	ref. 21
Computation is weak and relatively inaccurate; optimal theory of games strategy cannot be routinely expected.	Can be programmed to use optimum strategy for high-probability situations.	ref. 10

INTERPRETING

Human Capabilities and Limitations

Interpretation of complex physical energy inputs should be performed by personnel.

a. Interpretation, as used herein, refers to the capacity to recognize or ascribe meaning, contextual relations, or organization to sensed energy. As such, it represents a first level of processing. Of course, any equipment transformation involving transducing, filtering, or amplification functions can be thought of as interpretation in the sense of simple processing of signals. However, the concern here is with situations which involve more complex signal transformation and organization.

b. Because of his capabilities for attending to selected portions of his environment, detecting many forms of physical energy, ascribing meaning to them based on past experience, and responding with appropriate actions, man is more effective than equipment in many situations where transformation of inputs is required. This is most evident in the perception of patterns and recognition of these patterns in new or unusual stimulus situations. For example, this includes the capabilities of man to interpret wave forms on cathode ray tube displays, interpret radar and sonar display, etc. Examples of how this perception of patterns or relationships can be transferred from one situation to another are evidenced in man's ability to steer vehicles under varying environmental conditions. ref. 28

Man excels in locating and recognizing patterns, and making generalizations about them. He can perform many tasks which require use of this ability. ref. 31

Man has the "ability to recognize objects and places despite varying conditions of recognition." ref. 17

Man has the "ability to select own inputs". ref. 17

Use man for tasks requiring the discrimination of signals in noise. ref. 16

Use man where the task requires pattern discrimination in a changing field. ref. 16

Use man where discrimination must be made between multiple inputs. ref. 16

Psychologists and computer experts would '... list pattern recognition, particularly visual pattern recognition, as an important capability in which men far excel computers.' ref. 4

In perception the human has distinct advantages over machines. Humans perceive patterns, not isolated bits. These patterns are not restricted to one sensory modality, but may include some or all of them. The operator hears a strange sound and detects an unusual odor in conjunction with a change in rate or degree of vibration in a machine. He senses from this pattern that something is wrong and he will stop the machine before it destroys itself. The human can perceive the pattern of an airplane blip through noise far more effectively than can the tracking program of the SAGE computer. Similarly he is able to see patterns on oscilloscopes. Man can also perceive patterns of events occurring over time and thereby anticipate events; this is behind much of his ability to learn. ref. 7

Man exceeds computers in ability to recognize patterns in spite of transpositions, rotations, translations, and other distortions, which makes mechanical interpretation of complex visual displays, such as aerial photographs, or recognition of spoken words or longhand impractical. ref. 26

Man can consider time-linked phenomena and extrapolate from observed trends in completing his picture of the system's operation. ref. 26

Men have a high tolerance for ambiguity and uncertainty, based on life-long experience with ambiguity and the ability to translate uncertainty into probability. ref. 26

In many system instances, the most important function performed by the human being is interpreting. Here the individual makes outputs which, in effect, place inputs into categories whose basis is their effects rather than their appearances. In other words, interpreting is a matter of identifying the meaning of inputs. ref. 11

While both man and machine are currently capable of recognizing patterns from prescribed universes, only man can currently discern relational pattern among items from non-prescribed universes. ref. 5

Some limitations of human interpretive abilities should be noted:

a. Past perceptual experiences influence present interpretation and, conversely, current interpretive activities influence stored events and change them both qualitatively and quantitatively.

b. The reliability and content of signal interpretation is particularly susceptible to emotional and intellectual errors (both constant and sporadic), as well as physical degradation (decreased sensitivity because of sensory fatigue, etc). This problem of attaining and maintaining reliable and valid human interpretation of physical energy can be mitigated by adequate design engineering (e.g., information displays), personnel training (including practice and training support documents and materials), and on-the-job proficiency reinforcements, training and proficiency exercises, etc.). ref. 28

"... the human operator has certain tendencies to distort the meaning of stimuli, or to assign a meaning that was not intended." ref. 14

In prediction of future position, the human being has a strong bias to rely primarily on position, magnitude, or direction, and his perceptual judgments and motor responses are based only in small part on the higher derivatives of input signals. ref. 26

The human being can estimate rate of change in input, but he is not particularly accurate in perceptual estimation or in the use of such estimates to determine movement. ref. 26

Man is quite limited in estimates of acceleration characteristics, and reverts to estimates of velocity (rate smoothing) when a constantly accelerating input is withdrawn from view. ref. 26

The human being should not be required to estimate the acceleration characteristics or higher derivatives of input signals. ref. 26

Machine Capabilities and Limitations

Machines are better able to apply deductive reasoning, such as recognizing stimuli as belonging to a general class (with specified characteristics). ref. 15

Investigations of machine recognition of written or printed characters or spoken language show how primitive known electronic circuit principles are compared to the nervous system. ref. 15

Man-Machine Performance Comparison

MAN	MACHINE	
Man is able to use perceptual constancies; i.e., the spatial redundancy in the real world to "recognize" objects and places and thereby simplify otherwise very complex situations.	Machines have zero, or very limited ability to use perceptual constancies.	ref. 30
Man has high tolerance for ambiguity, uncertainty and vagueness.	Machines are highly limited by ambiguity and uncertainty in the input.	ref. 19
Man can interpret an input signal accurately even when subject to distraction, high noise or message gap.	Machines perform well only in a clean environment.	ref. 19
Man may introduce errors by identification, redintegration or closure.	Machines do not utilize these processes.	ref. 19
Expectation or cognitive set may lead an operator to see what he expects to see.	Machines do not exercise these processes.	ref. 19

DECISION MAKING

Human Capabilities and Limitations

Man is capable of integrating a large amount of information gathered from experience and bringing it to bear in a novel situation. ref. 19

Where the decision-making process is dependent upon maximum flexibility, assign it to the human in the system. ref. 20

Where the decision involves the consideration of a situation context in which the weightings of the factors involved vary in accordance with the context, assign it to the human in the system. ref. 20

Where the decision-making couples active hypothesis formulation with inductive reasoning, assign it to the human in the system. ref. 20

[Humans]... may be reprogrammed by self-instruction following input changes contingent on previous response (dynamic decision making). ref. 11

When all the alternatives cannot be specified in advance, true decision making is required and presumably this can only be done by human beings. ref. 29

Humans will continue to be utilized in several roles which are essential in the decision-making process. These include:

a. estimation of the likelihood of future contingencies

b. assignment of values (or losses) to each possible outcome

c. establishment of a risk philosophy

d. recognition of indications of low-probability events (or those which cannot be handled by the equipment)

e. review of selected actions before they are implemented (where the stakes are high). ref. 25

Dynamic decision making requires successive reprogramming, at each step of the way, of the filtering conditions in short-term memory. Thus at each new stage the individual must provide his own instructions to establish the filtering set which tells him "what to look for." This kind of flexible reprogramming constitutes one of the most striking characteristics of human functioning, and one which distinguishes it markedly from that of most machines. In performing in this manner, the individual must have available in his long-term memory the variety of "filtering rules" necessary and relevant to the problem to be solved. Choosing among them is the major task accomplished by interpretation. The rules themselves then come into play in determining the particular filtering set employed in the next stage of the problem; they are self-instructions, or programs. ref. 11

Humans can serve several useful functions (related to the interpretation of information) which are either beyond present computer capabilities, or else would require unrealistically complex equipment:

a. They can evaluate narrative information (such as intelligence reports) and "structure" or code it for machine processing, particularly if they are trained as specialists in limited areas of interest.

b. They can recognize unanticipated or low-probability events which their data-processing equipment has not been programmed to handle, particularly if they are alerted to the possibility that unusual events might occur. Further, they can attach confidence levels to their reports of these events.

c. They can recognize patterns of events (both temporal and spatial) which would require complex electronics to be recognized automatically. ref. 25

The ability to reason inductively, that is, to make generalizations from specific observations is perhaps man's greatest claim to fame. It is especially important in troubleshooting. But one of the reasons the inductive ability is so important is that the manual programming provisions (in the forms of maintenance instructions and graphic aids) are inadequate to the job, that is, they fail to provide adequate support for human deductions, especially in troubleshooting. Since the generalizations made by technicians are so often incorrect, the best test and check-out situation perhaps should require as little as possible of man's inductive ability....(this does not necessarily mean to automate.) ref. 24

Man is an exceptionally good evaluative computer. From intermittent information on a PPI display he is able to estimate courses, velocities, times, and points of interception with considerable accuracy. Man is able to make decisions based on past experience and patterns of visual or auditory inputs. He is the only available computer able to solve problems by logical induction. ref. 31

Throughout his lifetime, man selects and smooths information, estimates probabilities, anticipates alternative outcomes, and in various other ways learns to make decision in the face of excess, missing, or unreliable information. These abilities have many implications with respect to functions which he can perform in complex systems. ref. 8

Once we understand better how man uses heuristic procedures...in making decisions, we may be able to devise similar machine programs. ref. 8

Man...learns to make decisions in the face of excess, missing, or unreliable information. ref. 8

When estimates of conditions depend upon subjective or unanticipated factors that cannot be preprogrammed, men will be superior. ref. 26

Generalized information processing and decision making should be performed by personnel where:

a. Pattern perception is important (especially where patterns may change in size, position, or energy configuration (types and strength levels) under different conditions.

b. Long-term storage of information is required.

c. Insight, discovery, or heuristic problem solving is required.

d. Decision making and learning in a complex changing situation are required.

e. Ability to improvise and adopt flexible procedures is important and, within the state of the art, cannot be built into a machine program.

f. Number of low-probability events which might occur is high and the cost or capacity of machine programming is exceeded by the requirement.

g. Inductive reasoning is required, i.e., a requirement exists for generalizations to be made from the specific events. ref. 28

This suggest that a military-information-processing system which must cope with relatively unreliable data might profitably use human operators as transducers for probabilities. These probabilities could then be entered into a computer which would compute the optimal course of action. In one very important sense, man is far more reliable than computers: once he has learned to perform a task correctly, he does not usually repeat the same error, as does a computer with a broken part. ref. 26

Man's ability to make decisions in situations which he has not previously encountered, or to generalize from one situation to another, is an asset in his favor as a decision-maker. ref. 26

Man has considerable flexibility in dealing with unique situations for which all the relevant decision-making factors cannot be anticipated in advance. ref. 26

In sensing, extrapolating, and decision-making the computer may be given the primary function, but the man should be available as backup. In many such applications, it may be more economical and efficient to assign the entire function to the man. ref. 26

In general, human beings are superior to existing computers in making decisions for three reasons:

a. they are capable of inductive reasoning

b. they are able to make inferences from one set of conditions to another, and

c. they are capable of making decisions in situations which they have not previously encountered. ref. 26

In performing decision-making tasks, the man may not treat the total output of his information source equally. He may select and reject various incoming messages, and he adds his own evaluation to what has already been done; his criteria may be different from and superior to those of the intermediate processor, since he is likely to have overlapping information from a greater variety of sources. ref. 26

Machine Capabilities and Limitations

Where the decision-making process is dependent upon complex procedures requiring a large number of differentiations or integrations, assign it to the computer. ref. 20

Where the decision-making process is dependent upon infallible memory with its precise source accurately tagged (and ignoring display potential), assign it to the computer. ref. 20

Where the decision involves contextless deductive reasoning, assign it to the computer. ref. 20

Where the decision involves inductive reasoning of a straightforward nature, assign it to the computer. ref. 20

Where the decision-making involves prediction of the future and if the weightings of the variables involved are known, assign it to the computer. ref. 20

Specialized information processing and decision making should be performed by equipment where:

a. Deductive logic can be programmed.

b. Speed and amount of memory search or entry (storage) is an extensive requirement.

c. Highly complex computations or logical operations are involved.

d. Short-term storage and retrieval of large amounts of data is required.

e. System functioning requires extremely short time lags between scheduled events.

f. Many routines, channels, and memory areas must be utilized simultaneously (parallel operation).

g. A high degree of repetitiveness and routine is involved in the sequence of tasks or events.

h. Events are unambiguous and probable but can be expected to occur only infrequently, e.g., as in monitoring of equipment readiness.

i. Reduction of the over-all amount of work load and activity for personnel can be expected and provided within system cost parameters. ref. 28

Heuristic principles for searching functions should be applied when machines are given problem-solving duties. ref. 26

Man-Machine Performance Comparison

MAN	MACHINE
Man can make inductive decisions in novel situations, has the ability to generalize.	Machines have little or no capability for induction or generalization. ref. 19
Man does not always follow an optimum strategy.	Machines will always follow the strategy which is built into them. ref. 30
Man will require a review or rehersal period before making decisions based on items in memory.	Machines go directly to the item in memory required for the decision. ref. 19

STORING AND RETRIEVING INFORMATION

Human Capabilities and Limitations

Humans excell in the ability to store large amounts of information for long periods and to remember relevant facts at the appropriate time. ref. 24

Humans are generally better in their abilities to retrieve pertinent information from storage (recall), frequently retrieving many related items of information; but reliability of recall is low. ref. 15

Men have greater accessibility to items in storage since they can get at a single memory in many different ways. ref. 4

Man has a very limited short term (buffer) storage capacity; however once learning has taken place man is usually able quickly to call up the desired information or to reinstate a skill whenever it is needed. ref. 9

Short-term memory imposes certain limitations on the man's capacity for processing information, and may introduce various distortions. ref. 13

Memory. Man is reasonably efficient in tasks requiring long-term memory. ref. 5

The storage capacity of the human nervous system is larger than the capacity of all existing automata. The access time of this human storage of information is normally shorter than the access time of comparable mechanical storage devices. ref. 22

Man has good long-term memory for generalized experience, but rather poor immediate memory for most sensory functions. This is especially so in audition. His access time is slow, compared with that of a computer, but he is able to recall generalized patterns of previous experience to solve immediate problems. As yet, no computer can do this. ref. 31

An essential feature of all "functions of intelligence" is the storage of information. In man we have to distinguish two different principles of storage: short-term storage, e.g., applied in mental arithmetic for storing provisional results, and long-term storage, e.g., for learning languages, writing, or manual skills etc. ref. 22

Man can recover memories in many ways, simply by "searching" for them; machines, which can reproduce material that has been stored for a long time with speed and accuracy, cannot produce it without specific instructions as to its exact location. ref. 26

Man is able to store large amounts of information, and although his recall is often imperfect, he is able to make inferences upon the basis of past experience about the likely outcomes of given courses of action. ref. 26

Many computer experts agree that the most important respect in which men excel computers is in the accessibility of the items in storage. Men can get at a single memory in many different ways; in particular, they can recover memories on the basis of similarity alone. Computers, by contrast, have no such efficient cross-indexing. If they did, it would be possible to write programs which rely on the computer to locate and produce any item in memory without specific instruction concerning where that item is. At present, no such procedure is possible. ref. 4

Summary of man's information storage capability:

> Limited memory capacity with some inaccuracies. Slow. Storage not permanent. Number of channels that can record simultaneously limited and they will affect (interfere) with each other, though occasionally this is beneficial for augmenting a weak signal. ref. 2

Long-term storage and recall of meaningful material of considerable contextual complexity should be performed by personnel when:

a. Retention of abstract and symbolic material and its selective recall for a wide variety of applications is required.

b. Modification of retained material in the direction of new learning about a constantly changing environment is required

c. Judgment in situations is required where all the relevant factors cannot be clearly specified in advance.

d. Self-modifying behavior based upon retention of experienced events is required. ref. 28

One of man's most serious limitations in handling information arises from his very limited buffer storage (or immediate memory) capacity. ref. 8

The speed and accuracy of human recall is often poor. ref. 26

Machine Capabilities and Limitations

Computers excel men in long-term storage of immense amounts of information, and can reproduce it extremely accurately. ref. 4

Machines are generally better in the abilities to store coded information quickly and in substantial quantity (for example, large sets of numerical values can be stored very quickly). ref. 15

Storing and recalling large amounts of precise data for short periods of time. Especially in the computer field, there are requirements for short-term storage of information ("scratch pad" data), followed by complete erasure of the data in preparation for another task. Machines excel at this; humans not only have difficulty memorizing large amounts of information, but their recall is often spotty, and they have difficulty in completely erasing information in short-term storage. ref. 24

Storage of large amounts of data and recall for short periods of time should be performed by equipment when:

a. Information is low in meaningfulness to the human, even though it may ultimately be useful to him.

b. Encoding or identification for library search can be simpler than the symbolic processes utilized by humans for the purpose of recall.

c. Rapidly committing large amounts of information to storage is required, since humans often cannot recall information and apparently cannot completely erase learned material -- a factor which sometimes creates considerable unreliability and lack of validity in operator performance. ref. 28

Summary of machine information storage capability:

Able to accurately and rapidly store vast amounts of data for long periods of time. Can record on many channels simultaneously without interference. Does not process data unless instructed to do so. ref. 2

Man-Machine Performance Comparison

MAN	MACHINE	
Man has excellent long term memory for related events.	Machines can have this property, but are very expensive.	ref. 19
Man is not well adapted to high speed accurate search of large volumes of information.	Computers are built to do just this.	ref. 19
Man has extremely limited short-term (buffer) memory for factual material.	Machines may have as much buffer memory [as] can be afforded.	ref. 19
Limitation to rule storage not known.	Limits of rule storage ("logic") quite high.	ref. 11
Man has the ability to improvise and exercise judgment based on long term memory and recall.	Machines do not possess these properties; they are best at routine functions.	ref. 19

RESPONDING

Human Capabilities and Limitations

Man has the capability to act as an intermittent servo in the performance of a number of different systems or equipments. ref. 19

Man is better suited to situations where alternative modes of operation are likely to be required. ref. 19

Man has the capability for tracking through clutter in a wide variety of situations. ref. 17

Human controllers will probably continue to be replaced in many systems by automatic feedback control systems; however he can develop very high levels of skill. ref. 9

The responsibility for test system control is to be given to the operator, so that he and the system (i.e., automatic checkout equipment) can function most effectively. ref. 6

Man can guide and control equipment performing constructive operations to a degree that cannot be done any other way, since constant modifications and adjustments in the general method of performing any operation will be required to meet the conditions that prevail. ref. 1

Intermittent operation of equipment is possible if man is present as a controller and actuator through time to make the on-off decisions. ref. 18

These motor activity capabilities enable man to act upon the environment by manipulating controls, changing his position and location, transmitting information verbally to other men, and by lifting and moving objects. As in the case of man's data sensing and data processing capabilities, the motor capabilities of man are rarely used in isolation. ref. 21

In this role, man also has his capabilities and his limitations. He can push buttons and pedals, turn knobs, throw switches, and operate various other kinds of controls, provided such controls do not impose tasks that exceed his capabilities. Some of these can be listed as follows:

a. The forces that human operators can exert are limited.

b. Human operators are relatively slow in moving controls, as compared with machines. Also, compared with machines, human movements involve considerable time delay between the time the decision is made to move the control and the time the movement is initiated. Thus, when controls should be operated with little delay and with great speed, machines are superior to human beings.

c. Man is also limited in the kinds of movement he can make. He can reach in some directions and not in others, and he can reach or extend his limbs only for limited distances.

d. The precision with which man can apply a given force to a control is also limited. If asked to maintain a certain pressure on a control, the actual pressure will oscillate around the desired pressure and will approximate the desired pressure with some average (or constant) error.

e. The time during which man can apply a force is limited.

f. Man, as a controller, is easily overloaded. ref. 16

Man can talk, push buttons, use hand cranks or joysticks. He can point, write, push pedals, and so on. All of these outputs are usable and have been used in man-machine systems. It must be remembered that his motor performance characteristics vary considerably, depending upon the mode of response. ref. 31

As task-induced stress (increased input frequency) is introduced, the man generally reduces the weight assigned to higher derivatives of the input signal, and in this sense regresses toward a lower level of control. ref. 26

As the man is required to respond more rapidly or at the same rate to a greater number of stimuli, performance accuracy decreases proportionately. ref. 26

Human beings tend to react intermittently rather than continuously to stimuli, even if stimuli are continuous rather than discrete. For certain continuously changing stimuli it appears that human responses are made at the rate of about two per second. ref. 26.

Generally, two-way communication between the men should be minimized, so as to reduce the possibilities of error However, there is some feeling on the part of human factors specialists that completely eliminating such communication may have an adverse effect, since it tends to "dehumanize" the situation. ref. 26

Machine Capabilities and Limitations

When the identifications involved in tracking can be reduced to simple inputs varying in a single dimension, it is obvious that machine performance can easily be made to exceed that of a human operator. ref. 11

While man possesses many alternative modes of operation, when his size and weight are considered in relation to machines, for most specific modes of operation machines outstrip men. Machines can perform routine repetitive tasks without decrements due to boredom and fatigue. They can perform many different things simultaneously without man's physiological limitations. Machines can be built to respond much more quickly to control signals and can apply great forces smoothly and precisely. The ability of man to make control movements is limited in both power and speed. One advantage of using man's motor capability however, is his ability to change both position and location with relative ease. ref. 2

Man-Machine Performance Comparison

MAN	MACHINE
Generally not good at tracking although may be satisfactory where situation requires frequent reprogramming; can change tracking properties to produce best attainable system performance in any situation. Is best at position tracking with changes under 3 radians per second.	Good tracking characteristics easy to obtain for limited set of requirements, etc.; to track well in all conditions considerable complexity required. Properties fixed in each range.

ref. 30

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APPENDIX B
MAN-MACHINE TASK VS CAPABILITIES MATRIX

The following pages are a tabulation of the basic man-machine performance capabilities relevant to each generic air traffic control task. An X in a row-column intersection indicates that the performance capability is required to accomplish the task. The procedure for deriving this matrix is described in Section 3.3 of the report.

The key to the performance capability abbreviations is as follows:

MO - Monitoring
SE - Sensing
IP - Information Processing
IN - Interpreting
DM - Decision Making
SR - Information Storage and Retrieval

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
1.0	PROVIDE FLIGHT PLANNING INFORMATION						
1.1.1	Accept Data Link Request	X	X	X	X		
1.1.2	Accept Telephone Request	X	X	X	X		
1.1.3	Enter Request into System			X	X	X	X
1.2.1	Select Preformatted Reply				X	X	X
1.2.2	Retrieve Information Requested			X	X	X	X
1.3.1	Compile Non-Preformatted Response			X	X	X	
1.3.2	Display Information Requested			X			
1.3.3	Transmit Requested Information Via Telephone			X			
2.0	CONTROL TRAFFIC FLOW						
2.1.1	Select Terminal or Jurisdiction and Time Period to be Considered					X	X
2.1.2	Determine Effects of Weather on Capacity			X	X	X	X
2.1.3	Determine Effects of Airspace Restrictions on Capacity			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
2.1.4	Determine Effects of Ground Equipment Capability and Status on Capacity			X	X	X	X
2.1.5	Determine Effects of Flight Hazards on Capacity			X	X	X	X
2.1.6	Determine Total Effect on Capacity			X	X	X	X
2.2.1	Determine Jurisdiction/Terminal Demand due to Commercial Schedule			X			X
2.2.2	Process and Store Reservations			X		X	X
2.2.3	Determine Jurisdiction/Terminal Demand due to Reservations			X			X
2.2.4	Determine Total Jurisdiction/Terminal Demand			X			X
2.3.1	Compare Capacity with Demand			X	X		
2.3.2	Determine Origins of Demand in Capacity Overload Situations			X	X	X	X
2.3.3	Determine What Number of Aircraft are to be Delayed for What Period of Time			X	X	X	
2.3.4	Determine Where Delays are to be Absorbed			X	X	X	
2.3.5	Formulate Flow Control Directives			X		X	
3.0	PREPARE FLIGHT PLAN						

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
3.1.1	Specify Desired Destination and Route Information			X	X	X	X
3.1.2	Specify Aircraft and Pilot Information			X	X		X
3.1.3	Specify Type Flight Plan and Special Services Desired			X		X	
3.2.1	Obtain Operational, Environmental and Regulatory Information for Desired Route and Destination			X	X		X
3.2.2	Determine Modifications Required to make Prelim. Flight Plan Consistent with Operational, Environmental and Regulatory Info.			X	X	X	
3.2.3	Determine Effects of Required Modifications on Flight Intentions			X	X	X	
3.3.1	Compile Flight Plan			X			X
3.3.2	Check Flight Plan for Internal Consistency			X	X	X	
3.3.3	Submit Flight Plan			X			
4.0	PROCESS FLIGHT PLAN						
4.1.1	Determine Points for Which ETOV's are to be Computed			X	X	X	X
4.1.2	Compute ETOV's/ETA			X			X
4.2.1	Compare Flight Plan with Aircraft Capability and Status			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
4.2.2	Compare Flight Plan with Operational and Environmental Conditions			X	X	X	X
4.2.3	Probe for Conflicts Among Flight Plans			X	X	X	X
4.2.4	Compare Flight Plan with Flow Control Directives and Guidelines				X	X	X
4.2.5	Compare Flight Plan with Rules and Procedures			X	X	X	X
4.2.6	Compare Flight Plan with Flight Progress			X	X	X	X
4.2.7	Compare Flight Plan with User Class/Pilot Qualifications			X	X	X	X
4.2.8	Compile List of Discrepancies			X	X		X
4.2.9	Determine Flight Plan Priority				X	X	X
4.2.10	Determine Acceptability of Flight Plan				X	X	X
4.2.11	Identify Flight Plans that must be Modified as a Result of this Approval			X	X	X	X
4.2.12	Inform Pilot of Flight Plan Approval			X			
4.2.13	Determine Special Services Required			X	X	X	X
4.3.1	Determine Changes Required to Make Flight Plan Acceptable			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
4.3.2	Determine Responsibility to Modify the Flight Plan				X	X	X
4.3.3	Inform Pilot of Unacceptable Flight Plan			X			
4.3.4	Compile Modified Flight Plan			X			X
4.4.1	Receive and Enter Pilot's Response	X	X	X	X		
4.4.2	Cancel Flight Plan			X		X	X
4.4.3	Designate Responsible Jurisdictions				X	X	X
4.4.4	Designate Communication Links between ATM and Aircraft				X	X	X
5.0	ISSUE CLEARANCES AND CLEARANCE CHANGES						
5.1.1	Determine if Identification Code Assignment is Required				X	X	X
5.1.2	Compare Flight Progress with Clearance Limit and EFC Time	X		X		X	X
5.1.3	Determine Pilot Intentions Following Missed Approach	X	X	X			
5.2.1	Assign Identification Code			X			X
5.2.2	Determine Clearance Tolerances				X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
5.2.3	Determine Clearance Limit				X	X	X
5.2.4	Determine Required Clearance Instructions			X	X	X	X
5.3.1	Compile Clearance to be Issued			X			X
5.3.2	Transmit Clearance Message			X			
5.3.3	Receive Acknowledgement of Clearance	X	X	X	X		
6.0	MONITOR AIRCRAFT PROGRESS						
6.1.1	Receive/Enter Correlated Position and Identification	X	X	X			
6.1.2	Receive/Enter Position	X	X	X			
6.1.3	Correlate Position and Identification	X		X	X	X	X
6.1.4	Request Aircraft Identity	X		X			
6.1.5	Assign Arbitrary Aircraft Identification	X		X		X	X
6.2.1	Initiate Aircraft Actual Time-Position Profile		X	X		X	X
6.2.2	Update Aircraft Actual Time-Position Profile			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
6.3.1	Derive Rate of Change of Position		X	X			X
6.3.2	Compute Short-Range Extrapolations			X			
6.3.3	Compute Long-Range Extrapolations			X			
6.4.1	Determine Aircraft Readiness	X	X	X	X		
6.4.2	Detect Aircraft Emergencies	X	X	X	X		
6.4.3	Determine Nature of Emergency		X	X	X	X	X
6.4.4	Receive and Enter Aircraft Status Changes	X	X	X			X
6.4.5	Update Aircraft Status			X			X
6.4.6	Receive and Enter Reports of Aircraft Capability Changes	X	X	X			X
6.4.7	Update Aircraft Capability			X	X	X	X
7.0	MAINTAIN CONFORMANCE WITH FLIGHT PLAN						
7.1.1	Specify Time Period to be Checked			X	X	X	
7.1.2	Construct Pairs of Flight Plans to be Compared			X			X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
7.1.3	Select Relevant Portion of each Pair Member's Intended Time-Position Profile			X	X	X	X
7.1.4	Compare Intended Time-Position Profiles for Intersections in x, y, h & t			X	X		
7.1.5	Propose Revised Flight Plan to Correct Long-Term Conflicts Among Flight Plans			X	X	X	
7.2.1	Determine Aircraft's Intended Present Position			X	X		X
7.2.2	Compute Deviations between Aircraft's Intended and Actual Present Position			X			
7.3.1	Determine Aircraft's Intended Future Positions			X	X		X
7.3.2	Compute Short-Range Deviations (in x, y, h) from Flight Plan			X			X
7.3.3	Compute Long-Range Deviations (in t) from Flight Plan			X			X
7.4.1	Compare Deviations with Tolerances			X	X	X	X
7.4.2	Inform Pilot of Out-of-Tolerance Deviations			X			
7.4.3	Receive Pilot's Response Concerning Resolution of Out-of-Tolerance Present and/or Long-Range Deviations	X	X	X	X		
7.4.4	Develop Flight Plan Revisions to Correct Out-of-Tolerance Deviations			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
8.0	ASSURE SEPARATION OF AIRCRAFT						
8.1.1	Select Airspace Volume and Time Frame			X		X	X
8.1.2	Predict Aircraft Paths			X	X	X	X
8.1.3	Identify Path Prediction Profiles for the Airspace and Time Frame			X	X	X	
8.1.4	Pair Path Prediction Profiles for Conflict Comparison			X	X	X	
8.1.5	Determine Conflict Probability for each Pair			X	X	X	
8.1.6	Determine Conflict Imminence for each Pair			X	X	X	
8.1.7	Determine Action Required			X	X	X	
8.1.8	Monitor for Unexpected Deviations	X	X	X	X	X	
8.1.9	Determine if Action Classification has been Updated	X		X	X	X	X
8.2.1	Hypothesize Performance Changes			X	X	X	X
8.2.2	Analyze Performance Change for Conflicts			X	X	X	
8.2.3	Format Performance Change Message			X			

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
8.2.4	Transmit Performance Change Message to Pilot			X			
8.2.5	Determine Performance Change Status	X	X	X	X	X	
9.0	CONTROL SPACING OF AIRCRAFT						
9.1.1	Determine Identity and ETA of Arriving Aircraft			X			X
9.1.2	Determine Identity and ETD of Departing Aircraft			X			X
9.1.3	List Arriving and Departing Aircraft and ETA/ETD			X			X
9.2.1	Determine Airport Capacity			X	X	X	
9.2.2	Analyze Predicted Schedule for Alternating Periods of Excess Demand and Slack			X	X	X	
9.3.1	Analyze Temporal Distribution of Arrivals and Departures			X	X		
9.3.2	Allocate Blocks of Time for Arrivals and Departures				X	X	
9.4.1	Compare Predicted Arrival and Departure Times with Runway Schedule			X		X	X
9.4.2	Change ETA's and ETD's to be Compatible with Runway Schedule			X		X	
9.5.1	Select Sequence/Schedule Change to be Implemented			X	X	X	

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
9.5.2	Hypothesize Performance Change Required to Implement Desired Sequence/Schedule			X	X	X	
9.5.3	Check Proposed Performance Change for Predicted Conflict			X	X	X	X
9.5.4	Assess Control Implications of Performance Required to Implement Sequence/Schedule Change			X	X	X	X
9.5.5	Submit Performance Changes within Existing Flight Plan to Clearance Function			X			
9.5.6	Propose Revised Flight Plan to Implement Sequence/Schedule Change			X	X	X	X
9.5.7	Submit Revised Flight Plan for Approval			X			
11.0	PROVIDE AIRCRAFT GUIDANCE						
11.1.1	Determine Desired Position			X	X	X	
11.1.2	Determine Requirements for Further Vectoring		X	X	X	X	X
11.2.1	Measure Course and Distance		X	X	X	X	
11.2.2	Compute Time Interval			X			X
11.2.3	Compute Ground Speed			X			
11.2.4	Compute Altitude Difference			X			

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
11.3.1	Compute Airspeed			X			
11.3.2	Compute Vertical Speed			X			
11.3.3	Compute Heading			X			
11.4.1	Compute Heading Command			X	X		
11.4.2	Compute Airspeed Command			X	X		
11.4.3	Compute Vertical Speed Command			X	X		
11.5.1	Compile Vectoring Instructions			X	X	X	
11.5.2	Transmit Vectoring Instructions to Pilot			X		X	
11.5.3	Assess Aircraft Response	X	X	X	X	X	
12.0	ISSUE FLIGHT ADVISORIES AND INSTRUCTIONS						
12.1.1	Receive Pilot's Request for Information	X	X	X	X		
12.1.2	Acknowledge Pilot Request for Information			X			
12.1.3	Select Applicable Preformatted Messages				X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
12.1.4	Retrieve Information Requested			X	X	X	X
12.1.5	Compile Special Response to Request			X	X	X	
12.1.6	Transmit Preformatted Advisory to Pilot			X			
12.1.7	Transmit Special Response to Pilot			X			
12.2.1	Evaluate Advisory for Data Content			X	X	X	
12.2.2	Determine Aircraft to Which Information Applies			X	X	X	X
12.2.3	Determine Method of Flight Advisory Distribution			X	X	X	
12.2.4	Determine Distribution Position for each Identified Aircraft			X	X	X	X
12.2.5	Determine Time of Simultaneous Distribution			X	X	X	
12.2.6	Prepare Transmission Schedule			X	X	X	
12.2.7	Correlate Present Position with Distribution Position			X	X	X	
12.3.1	Determine Endangered Aircraft		X	X	X	X	
12.3.2	Compile Alert Message			X			

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
12.3.3	Transmit Warning Advisory to Pilot			X			
12.3.4	Receive Pilot's Response	X	X	X	X	X	
13.0	HANDOFF						
13.1.1	Correlate Aircraft Position with Jurisdictional Boundaries					X	X
13.1.2	Determine Functions to be Transferred					X	X
13.1.3	Correlate Aircraft Position with Airspace Structure Boundaries					X	X
13.1.4	Receive Pilot's Request for Transfer of Responsibility	X	X	X	X		X
13.1.5	Determine Acceptability to Jurisdictions Involved			X	X	X	X
13.2.1	Determine if Communication Channel Change is Required					X	X
13.2.2	Determine Availability of Appropriate Channels				X	X	X
13.2.3	Designate Channel to be Used					X	
13.3.1	Transfer Responsibility for Control						X
13.3.2	Compile Required Information for Clearance Function			X			X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
14.0	MAINTAIN SYSTEM RECORDS						
14.1.1	Detect Information Requiring Operational Report	X	X	X	X	X	X
14.1.2	Retrieve Applicable Operational Report Format				X	X	X
14.1.3	Enter Detected Information			X	X		X
14.1.4	Determine Necessity for Additional Information			X	X	X	
14.1.5	Retrieve Additional Information			X			
14.2.1	Classify Data Elements	X	X	X	X	X	
14.2.2	Assign Appropriate Identifiers			X	X	X	
14.2.3	Determine if Data Transform/Reformat is Required			X	X	X	
14.2.4	Transform/Reformat Data Element			X	X	X	
14.2.5	Enter Data Element into Storage						X
14.3.1	Determine if Report is Available			X	X	X	X
14.3.2	Retrieve Format					X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
14.3.3	Develop Format			X	X	X	
14.3.4	Retrieve Required Data				X	X	X
14.3.5	Analyze Data			X	X	X	
14.3.6	Compile Report			X			
15.0	PROVIDE ANCILLARY AND SPECIAL SERVICES						
15.1.1	Compile/Update Description of Special Service Required	X	X	X	X	X	
15.1.2	Monitor Progress of Service	X	X	X	X	X	
15.2.1	Determine Requirement for Special Flight Plan Priority			X	X	X	X
15.2.2	Establish Area of Restriction			X	X	X	X
15.2.3	Determine Guidance Service Required			X	X	X	X
15.2.4	Determine Special Separation Minima			X	X	X	X
15.2.5	Determine Advisories Required			X	X	X	X
15.2.6	Determine Necessity for Issuance of NOTAM(s)			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
16.0	PROVIDE EMERGENCY SERVICES						
16.1.1	Determine Adequacy of Emergency Description	X	X	X	X	X	
16.1.2	Request Additional Required Information			X	X	X	
16.1.3	Compile Description of Emergency		X	X	X	X	
16.2.1	Determine Required Ground Support Assistance			X	X	X	
16.2.2	Determine Assistance Required from Other Aircraft			X	X	X	
16.2.3	Determine Aircraft to Provide Assistance			X	X	X	X
16.2.4	Issue Instructions to Aircraft Providing Assistance			X			
16.2.5	Determine Required Technical Instructions to Aircraft in Emergency Situation			X	X	X	
16.2.6	Determine Emergency Flight Plan			X	X	X	X
16.2.7	Determine Requirement for Use of Emergency Communication Link			X	X	X	X
16.2.8	Inform Pilot of Change to Emergency Frequency Link			X			

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
16.2.9	Determine Required Guidance Assistance			X	X	X	X
16.2.10	Issue Instructions to Ground Support Facility			X			
17.0	MAINTAIN SYSTEM CAPABILITY AND STATUS INFORMATION						
17.1.1	Determine if Weather Observation Report is Required	X	X	X	X	X	X
17.1.2	Determine if Supplemental Data is Required			X	X	X	X
17.1.3	Request PIREP			X	X	X	
17.1.4	Receive Supplemental Data	X	X	X			
17.1.5	Make Weather Observation Report		X	X	X	X	X
17.1.6	Transmit Weather Observation Report			X			
17.1.7	Receive and Enter Weather Information	X	X	X	X		
17.1.8	Store Weather Information						X
17.2.1	Determine Data Base Item Affected			X	X	X	
17.2.2	Retrieve Affected Data Base Item						X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
17.2.3	Determine Required Change to the Data Base Item			X	X	X	
17.2.4	Purge Affected Data Base Item			X	X	X	X
17.2.5	Format New Data Base Item			X	X	X	
17.2.6	Store Data Base Item						X
17.3.1	Determine Data Base Item Affected			X	X	X	
17.3.2	Retrieve Affected Data Base Item						X
17.3.3	Determine Required Change to the Data Base Item			X	X	X	
17.3.4	Purge Affected Data Base Item			X	X	X	X
17.3.5	Format New Data Base Item			X	X	X	
17.3.6	Store Data Base Item						X
17.4.1	Determine Data Base Item Affected			X	X	X	
17.4.2	Retrieve Affected Data Base Item						X
17.4.3	Determine Required Change to the Data Base Item			X	X	X	

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
17.4.4	Purge Affected Data Base Item			X	X	X	X
17.4.5	Format New Data Base Item			X	X	X	
17.4.6	Store Data Base Item						X
17.5.1	Determine Data Base Item Affected			X	X	X	
17.5.2	Retrieve Affected Data Base Item						X
17.5.3	Determine Required Change to the Data Base Item			X	X	X	
17.5.4	Purge Affected Data Base Item			X	X	X	X
17.5.5	Format New Data Base Item			X	X	X	
17.5.6	Store Data Base Item						X
17.6.1	Determine Data Base Item Affected			X	X	X	
17.6.2	Retrieve Affected Data Base Item						X
17.6.3	Determine Required Change to the Data Base Item			X	X	X	
17.6.4	Purge Affected Data Base Item			X	X	X	X

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
17.6.5	Format New Data Base Item			X	X	X	
17.6.6	Store Data Base Item						X
17.7.1	Monitor COMM and NAV Systems for Status Change	X	X	X	X	X	
17.7.2	Activate Standby Equipment		X	X	X	X	
17.7.3	Retrieve Affected Data Base Item			X	X	X	X
17.7.4	Format New Data Base Item			X	X	X	
17.7.5	Store Data Base Item						X
17.8.1	Monitor Ground Facilities for Status Change	X	X	X	X		
17.8.2	Activate Standby Equipment		X	X	X	X	
17.8.3	Retrieve Affected Data Base Item			X	X	X	X
17.8.4	Format New Data Base Item			X	X	X	
17.8.5	Store Data Base Item						X
17.9.1	Receive and Index User Class Information	X	X	X	X	X	

TASK NO.	TASK TITLE	PERFORMANCE CAPABILITY					
		MO	SE	IP	IN	DM	SR
17.9.2	Retrieve Affected Data Base Item						X
17.9.3	Determine Change Required			X	X	X	
17.9.4	Purge Affected User Class Data Base Item			X			X
17.9.5	Format User Class Data Base Item			X	X		
17.9.6	Store User Class Data Base Item						X
17.10.1	Maintain Tallies of Active Flight Plans			X			X
17.10.2	Compile ETD's, ETOV's, and ETA's			X			X
17.10.3	Store Traffic Data						X
17.11.1	Determine Requirement for Preformatted Data Modules		X	X	X	X	X
17.11.2	Compile Preformatted Data Modules			X			X

APPENDIX C
TASK PERFORMANCE CAPABILITY RATINGS

This appendix contains a complete listing of the performance capability scores assigned by individual raters for each air traffic management task*. Each page is a tabulation of all scores for a single rater, arranged in the following format:

				PERFORMANCE CAPABILITY					
RATER ID NO.	FUNCTION NO.	SUBFUNCTION NO.	TASK NO.	MONITORING	SENSING	INFORMATION PROCESSING	INTERPRETING	DECISION MAKING	STORING & RETRIEVING INFO.
01	01	01	01	070	090	040	060	000	000

Entries in the performance capability columns are the scores assigned by the rater, encoded as follows:

000	No rating requested and none assigned
001 - 099	Rating requested and assigned
101 - 199	No rating requested, but rater believed performance capability was relevant to the task and so assigned a rating
200	Rating requested, but rater declined to rate the task

Therefore, within each three-digit group, the first digit indicates the condition by which the score was assigned, and the last two digits are the score itself.

*Note scores are shown for Tasks 2.2.5 and 4.4.5 which were discarded from the functional analysis. No scores are shown for Task 9.2.2 which was added to the functional analysis subsequent to rating of tasks.

RATER NO. 1

01	010101	070	090	040	060	000	000	010102	050	030	080	040	000	000	010103	000	000	040	040	005	050	010201	000	000	000	010	060	090
01	010202	000	000	085	010	070	090	010301	000	000	070	005	030	000	010302	000	000	095	000	000	000	010303	000	000	001	000	000	000
01	020101	000	000	000	000	075	050	020102	000	000	070	080	001	065	020103	000	000	070	080	001	050	020104	000	000	070	080	001	050
01	020105	000	000	070	080	001	090	020106	000	000	075	080	010	060	020201	000	000	090	000	000	070	020202	000	000	080	000	020	050
01	020203	000	000	090	000	000	070	020204	000	000	080	000	000	060	020205	000	000	090	030	000	000	020301	000	000	090	010	000	000
01	020302	000	000	090	030	020	080	020303	000	000	090	030	030	000	020304	000	000	090	030	030	000	020305	000	000	080	000	020	000
01	030101	000	000	001	001	001	040	030102	000	000	001	001	000	040	030103	000	000	010	000	001	000	030201	000	000	030	020	000	090
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RATER NO. 2

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02	170906	000	000	000	000	000	070	171001	000	000	071	000	000	075	171002	000	000	075	000	000	076	171003	000	000	000	000	000	071
02	171101	000	035	069	050	069	030	171102	000	000	072	000	000	035														

RATER NO. 3

03 010101 085 085 060 085 000 000	010102 010 010 010 010 000 000	010103 000 000 030 010 020 001	010201 000 000 000 010 080 010
03 010202 000 000 040 035 050 010	010301 000 000 010 010 015 000	010302 000 000 090 000 000 000	010303 000 000 010 000 000 000
03 020101 000 000 000 000 085 095	020102 000 000 025 040 085 030	020103 000 000 035 040 085 030	020104 000 000 045 040 080 030
03 020105 000 000 035 040 080 030	020106 000 000 055 040 060 045	020201 000 000 090 000 000 095	020202 000 000 090 000 085 095
03 020203 000 000 090 000 000 080	020204 000 000 090 000 000 085	020205 000 000 075 060 000 000	020301 000 000 090 060 000 000
03 020302 000 000 090 060 085 065	020303 000 000 090 050 080 000	020304 000 000 080 045 080 000	020305 000 000 075 000 080 000
03 030101 000 000 050 010 050 010	030102 000 000 001 030 000 010	030103 000 000 001 000 050 000	030201 000 000 010 020 000 015
03 030202 000 000 020 020 035 000	030203 000 000 035 020 040 000	030301 000 000 025 000 000 035	030302 000 000 020 015 030 000
03 030303 000 000 001 000 000 000	040101 000 000 020 050 085 020	040102 000 000 080 000 000 020	040201 000 000 005 035 050 020
03 040202 000 000 005 035 040 020	040203 000 000 050 035 045 040	040204 000 000 000 035 035 025	040205 000 000 005 035 035 025
03 040206 000 000 050 045 045 030	040207 000 000 005 040 075 035	040208 000 000 005 040 000 030	040209 000 000 000 050 075 015
03 040210 000 000 000 045 030 035	040211 000 000 035 045 055 035	040212 000 000 001 000 000 000	040213 000 000 005 015 050 040
03 040301 000 000 005 025 040 035	040302 000 000 000 025 030 020	040303 000 000 001 000 000 000	040304 000 000 010 000 000 025
03 040401 030 015 010 001 000 000	040402 000 000 001 000 005 005	040403 000 000 000 025 095 070	040404 000 000 000 020 070 040
03 040405 000 000 005 000 070 065	050101 000 000 000 020 060 050	050102 065 000 025 000 080 035	050103 030 015 005 000 000 000
03 050201 000 000 075 000 000 075	050202 000 000 000 003 030 010	050203 000 000 000 035 040 025	050204 000 000 005 030 005 010
03 050301 000 000 005 000 000 030	050302 000 000 001 000 000 000	050303 031 015 002 065 000 000	060101 090 099 020 000 000 000
03 060102 095 099 015 000 000 000	060103 005 000 075 040 080 065	060104 003 000 005 000 000 000	060105 060 000 010 000 065 070
03 060201 000 001 008 000 020 055	060202 000 000 030 025 070 065	060301 000 001 095 000 000 075	060302 000 000 096 000 000 000
03 060303 000 000 095 000 000 000	060401 094 090 005 060 000 000	060402 035 085 002 005 000 000	060403 000 040 007 005 010 010
03 060404 060 080 005 000 000 005	060405 000 000 010 000 000 040	060406 075 070 010 000 000 045	060407 000 000 012 015 015 050
03 070101 000 000 030 020 080 000	070102 000 000 099 000 000 099	070103 000 000 085 055 065 098	070104 000 000 099 015 000 000
03 070105 000 000 030 075 060 000	070201 000 000 050 019 000 030	070202 000 000 080 000 000 000	070301 000 000 085 080 000 060
03 070302 000 000 060 000 000 065	070303 000 000 060 000 000 055	070401 000 000 075 040 061 065	070402 000 000 005 000 000 000
03 070403 045 095 005 005 000 000	070404 000 000 035 055 059 020	080101 000 000 200 000 090 090	080102 000 000 065 070 060 090
03 080103 000 000 090 080 085 000	080104 000 000 099 099 099 000	080105 000 000 099 090 090 000	080106 000 000 099 090 095 000
03 080107 000 000 090 090 090 000	080108 030 010 050 045 050 000	080109 200 000 075 080 070 070	080201 000 000 025 030 020 035
03 080202 000 000 080 080 075 000	080203 000 000 200 175 000 000	080204 000 000 070 000 000 000	080205 005 200 020 030 040 000
03 090101 000 000 025 000 000 075	090102 000 000 025 000 000 070	090103 000 000 045 000 000 080	090201 000 000 055 070 075 000
03 090301 000 000 075 025 000 000	090302 000 000 000 035 030 000	090401 000 000 040 000 060 080	090402 000 000 045 000 060 000
03 090501 000 000 030 030 045 000	090502 000 000 020 045 075 000	090503 000 000 070 035 030 045	090504 000 000 050 065 080 040
03 090505 000 000 001 000 000 000	090506 000 000 020 040 001 030	090507 000 000 001 000 000 000	110101 000 000 090 090 090 000
03 110102 000 200 010 025 020 020	110201 000 200 090 200 200 000	110202 000 000 090 000 000 200	110203 000 000 090 000 000 000
03 110204 000 000 090 000 000 000	110301 000 000 090 000 000 000	110302 000 000 090 000 000 000	110303 000 000 090 000 000 000
03 110401 000 000 090 200 000 000	110402 000 000 090 200 000 000	110403 000 000 090 200 000 000	110501 000 000 010 020 020 000
03 110502 000 000 090 000 075 000	110503 090 200 010 075 070 000	120101 050 001 050 050 000 000	120102 000 000 050 000 000 000
03 120103 000 000 000 010 080 010	120104 000 000 080 020 050 090	120105 000 000 050 015 200 000	120106 000 000 050 000 000 000
03 120107 000 000 050 000 000 000	120201 000 000 050 035 200 000	120202 000 000 075 045 075 090	120203 000 000 050 015 040 000
03 120204 000 000 075 005 200 060	120205 000 000 075 025 010 000	120206 000 000 050 035 035 000	120207 000 000 050 200 035 000
03 120301 000 200 075 015 035 000	120302 000 000 075 000 000 000	120303 000 000 050 000 000 000	120304 050 001 050 200 200 000
03 130101 000 000 000 000 075 060	130102 000 000 000 000 030 025	130103 000 000 000 000 045 050	130104 090 080 015 060 000 035
03 130105 000 000 025 065 055 060	130201 000 000 000 000 080 070	130202 000 000 000 010 065 065	130203 000 000 000 000 060 000
03 130301 000 000 000 000 000 010	130302 000 000 010 000 000 025	140101 010 010 010 010 015 020	140102 000 000 000 010 020 025
03 140103 000 000 010 010 000 010	140104 000 000 010 010 010 000	140105 000 000 010 000 000 000	140201 090 090 090 090 085 000
03 140202 000 000 090 090 090 000	140203 000 000 090 075 085 000	140204 000 000 090 050 080 000	140205 000 000 000 000 000 099
03 140301 000 000 090 080 090 090	140302 000 000 000 000 200 010	140303 000 000 010 010 010 000	140304 000 000 000 200 090 090
03 140305 000 000 090 200 090 000	140306 000 000 090 000 000 000	150101 025 200 010 010 010 000	150102 025 200 010 010 010 000
03 150201 000 000 010 010 010 010	150202 000 000 010 010 010 010	150203 000 000 010 010 010 010	150204 000 000 010 010 010 010
03 150205 000 000 010 010 010 010	150206 000 000 010 010 010 010	160101 200 200 010 010 010 000	160102 000 000 010 010 010 000
03 160103 000 010 010 010 010 000	160201 000 000 010 010 010 000	160202 000 000 010 010 010 000	160203 000 000 075 050 050 050
03 160204 000 000 010 000 000 000	160205 000 000 010 010 010 000	160206 000 000 010 010 010 010	160207 000 000 010 010 010 010
03 160208 000 000 010 000 000 000	160209 000 000 010 010 010 010	160210 000 000 010 000 000 000	170101 040 090 015 075 075 010
03 170102 000 000 025 060 010 200	170103 000 000 075 050 075 000	170104 075 200 075 000 000 000	170105 000 090 090 200 200 090
03 170106 000 000 090 000 000 000	170107 090 200 200 200 000 000	170108 000 000 000 000 000 090	170201 000 000 090 090 090 000
03 170202 000 000 000 000 000 090	170203 000 000 090 070 070 000	170204 000 000 090 090 090 090	170205 000 000 090 090 090 000
03 170206 000 000 000 000 000 090	170301 000 000 090 090 090 000	170302 000 000 000 000 000 090	170303 000 000 090 070 070 000
03 170304 000 000 090 090 090 090	170305 000 000 090 090 090 000	170306 000 000 000 000 000 090	170401 000 000 090 090 090 000
03 170402 000 000 000 000 000 090	170403 000 000 090 070 070 000	170404 000 000 090 090 090 090	170405 000 000 090 090 090 000
03 170406 000 000 000 000 000 090	170501 000 000 090 090 090 000	170502 000 000 000 000 000 090	170503 000 000 090 070 070 000
03 170504 000 000 090 090 090 090	170505 000 000 090 090 090 000	170506 000 000 000 000 000 090	170601 000 000 090 090 090 000
03 170602 000 000 000 000 000 090	170603 000 000 090 070 070 000	170604 000 000 090 090 090 090	170605 000 000 090 090 090 000
03 170606 000 000 000 000 000 090	170701 050 050 085 085 200 000	170702 000 200 030 075 075 000	170703 000 000 080 080 080 090
03 170704 000 000 075 075 070 000	170705 000 000 000 000 000 090	170801 050 050 085 085 000 000	170802 000 200 030 075 075 000
03 170803 000 000 080 080 080 090	170804 000 000 075 075 070 000	170805 000 000 000 000 000 090	170901 050 200 200 075 075 000
03 170902 000 000 000 000 000 090	170903 000 000 090 070 070 000	170904 000 000 090 000 000 090	170905 000 000 090 090 000 000
03 170906 000 000 000 000 000 090	171001 000 000 099 000 000 099	171002 000 000 090 000 000 090	171003 000 000 000 000 000 099
03 171101 000 000 000 035 075 200	171102 000 000 040 000 000 030		

RATER NO. 4

04 010101 085 090 055 040 000 000	010102 092 099 200 095 000 000	010103 000 000 045 090 099 094	010201 000 000 000 099 099 010
04 010202 000 000 081 090 093 099	010301 000 000 099 070 020 000	010302 000 000 005 000 000 000	010303 000 000 200 000 000 000
04 020101 000 000 000 000 090 093	020102 000 000 071 065 093 093	020103 000 000 071 065 093 093	020104 000 000 071 065 093 093
04 020105 000 000 071 065 093 093	020106 000 000 075 021 096 010	020201 000 000 080 000 000 080	020202 000 000 023 000 096 021
04 020203 000 000 075 000 000 080	020204 000 000 075 000 000 085	020205 000 000 080 070 000 000	020301 000 000 070 010 000 000
04 020302 000 000 063 010 055 010	020303 000 000 060 040 065 000	020304 000 000 030 070 085 000	020305 000 000 060 000 090 000
04 030101 000 000 035 005 010 200	030102 000 000 080 005 000 200	030103 000 000 030 000 010 000	030201 000 000 055 080 000 093
04 030202 000 000 060 083 005 000	030203 000 000 067 033 043 000	030301 000 000 022 000 000 200	030302 000 000 025 030 065 000
04 030303 000 000 200 000 000 000	040101 000 000 020 092 097 072	040102 000 000 075 000 000 090	040201 000 000 070 000 098 090
04 040202 000 000 068 010 090 090	040203 000 000 066 010 093 080	040204 000 000 000 012 090 086	040205 000 000 005 005 092 086
04 040206 000 000 005 005 098 092	040207 000 000 005 005 094 092	040208 000 000 092 007 000 010	040209 000 000 000 080 094 083
04 040210 000 000 000 005 098 010	040211 000 000 082 080 073 084	040212 000 000 021 000 000 000	040213 000 000 076 010 082 092
04 040301 000 000 080 045 090 062	040302 000 000 000 072 090 083	040303 000 000 081 000 000 000	040304 000 000 090 000 000 025
04 040401 092 095 060 092 000 000	040402 000 000 080 000 099 085	040403 000 000 000 089 099 089	040404 000 000 000 085 096 092
04 040405 000 000 200 000 097 044	050101 000 000 000 035 090 072	050102 033 000 025 000 095 075	050103 035 065 033 000 000 000
04 050201 000 000 082 000 000 060	050202 000 000 000 030 090 052	050203 000 000 000 050 092 074	050204 000 000 080 074 069 048
04 050301 000 000 092 000 000 010	050302 000 000 200 000 000 000	050303 090 065 075 060 000 000	060101 098 092 074 000 000 000
04 060102 098 091 077 000 000 000	060103 020 000 080 090 084 057	060104 200 000 088 000 000 000	060105 096 000 079 000 082 065
04 060201 000 094 082 000 200 200	060202 000 000 091 074 080 078	060301 000 089 069 000 000 080	060302 000 000 094 000 000 000
04 060303 000 000 058 000 000 000	060401 098 092 066 094 000 000	060402 098 092 065 094 000 000	060403 000 088 090 089 015 080
04 060404 098 092 065 000 000 200	060405 000 000 090 000 000 098	060406 098 092 066 000 000 200	060407 000 000 094 072 065 098
04 070101 000 000 065 001 080 000	070102 000 000 075 000 000 080	070103 000 000 080 025 090 085	070104 000 000 085 072 000 000
04 070105 000 000 088 200 090 000	070201 000 000 015 085 000 050	070202 000 000 065 000 000 000	070301 000 000 048 080 000 075
04 070302 000 000 080 175 000 080	070303 000 000 080 175 000 080	070401 000 000 080 200 098 080	070402 000 000 005 000 000 000
04 070403 090 095 096 095 000 000	070404 000 000 092 040 088 090	080101 000 000 025 000 099 085	080102 000 000 090 090 093 099
04 080103 000 000 075 040 092 000	080104 000 000 050 092 060 000	080105 000 000 035 083 095 000	080106 000 000 040 082 097 000
04 080107 000 000 095 040 030 000	080108 099 055 060 090 035 000	080109 030 000 070 085 035 040	080201 000 000 083 090 080 036
04 080202 000 000 090 095 080 000	080203 000 000 099 000 000 000	080204 000 000 200 000 000 000	080205 095 095 060 080 075 000
04 090101 000 000 080 000 000 075	090102 000 000 085 000 000 075	090103 000 000 070 000 000 080	090201 000 000 062 021 092 000
04 090301 000 000 064 084 000 000	090302 000 000 000 089 093 000	090401 000 000 060 000 090 045	090402 000 000 072 000 089 000
04 090501 000 000 065 065 075 000	090502 000 000 070 085 089 000	090503 000 000 065 085 092 084	090504 000 000 068 090 093 065
04 090505 000 000 200 000 000 000	090506 000 000 035 082 080 043	090507 000 000 200 000 000 000	110101 000 000 030 085 099 000
04 110102 000 095 200 200 099 200	110201 000 095 200 200 099 000	110202 000 000 090 000 000 010	110203 000 000 099 000 000 000
04 110204 000 000 099 000 000 000	110301 000 000 099 000 000 000	110302 000 000 099 000 000 000	110303 000 000 099 000 000 000
04 110401 000 000 099 200 190 000	110402 000 000 099 200 190 000	110403 000 000 099 200 190 000	110501 000 000 092 200 090 000
04 110502 000 000 200 000 099 000	110503 095 095 070 070 095 000	120101 090 090 085 095 000 000	120102 000 000 090 000 000 000
04 120103 000 000 000 040 099 080	120104 000 000 070 020 085 085	120105 000 000 099 200 200 000	120106 000 000 005 000 000 000
04 120107 000 000 005 000 000 000	120201 000 000 075 075 040 000	120202 000 000 050 055 085 060	120203 000 000 060 060 090 000
04 120204 000 000 060 060 090 200	120205 000 000 030 045 095 000	120206 000 000 030 045 095 000	120207 000 000 030 045 095 000
04 120301 000 200 030 045 095 000	120302 000 000 085 000 000 000	120303 000 000 200 000 000 000	120304 200 020 090 045 040 000
04 130101 000 000 000 000 090 082	130102 000 000 000 000 094 060	130103 000 000 000 000 090 035	130104 070 025 015 050 000 042
04 130105 000 000 021 090 085 060	130201 000 000 000 000 093 020	130202 000 000 000 070 065 040	130203 000 000 000 000 095 000
04 130301 000 000 000 000 000 200	130302 000 000 092 000 000 030	140101 030 030 060 080 085 074	140102 000 000 000 200 090 090
04 140103 000 000 200 075 000 085	140104 000 000 065 080 085 000	140105 000 000 080 000 000 000	140201 030 030 073 075 080 000
04 140202 000 000 200 083 090 000	140203 000 000 040 090 090 000	140204 000 000 060 080 095 000	140205 000 000 000 000 000 090
04 140301 000 000 065 060 095 080	140302 000 000 000 000 095 098	140303 000 000 010 089 090 000	140304 000 000 000 200 095 098
04 140305 000 000 094 085 060 000	140306 000 000 095 000 005 000	150101 025 028 054 040 010 000	150102 024 025 078 060 095 000
04 150201 000 000 015 044 010 010	150202 000 000 015 044 010 010	150203 000 000 015 044 010 010	150204 000 000 015 044 010 010
04 150205 000 000 015 044 010 010	150206 000 000 015 044 010 010	160101 030 030 062 055 085 000	160102 000 000 080 021 090 000
04 160103 000 065 084 015 020 000	160201 000 000 075 020 020 000	160202 000 000 075 020 020 000	160203 000 000 052 040 095 060
04 160204 000 000 045 000 000 000	160205 000 000 090 010 095 000	160206 000 000 095 020 098 080	160207 000 000 060 080 080 020
04 160208 000 000 045 000 000 000	160209 000 000 075 020 020 200	160210 000 000 045 000 000 000	170101 099 099 080 099 099 040
04 170102 000 000 050 045 095 030	170103 000 000 065 075 085 000	170104 085 060 010 000 000 000	170105 000 089 080 045 020 030
04 170106 000 000 040 000 000 000	170107 050 050 010 010 000 000	170108 000 000 000 000 000 099	170201 000 000 200 095 095 000
04 170202 000 000 000 000 000 099	170203 000 000 200 085 095 000	170204 000 000 200 030 095 095	170205 000 000 095 025 090 000
04 170206 000 000 000 000 000 090	170301 000 000 200 095 095 000	170302 000 000 000 000 000 099	170303 000 000 200 085 095 000
04 170304 000 000 200 030 095 095	170305 000 000 095 025 090 000	170306 000 000 000 000 000 090	170401 000 000 200 095 095 000
04 170402 000 000 000 000 000 099	170403 000 000 200 085 095 000	170404 000 000 200 030 095 095	170405 000 000 095 025 090 000
04 170406 000 000 000 000 000 090	170501 000 000 200 095 095 000	170502 000 000 000 000 000 099	170503 000 000 200 085 095 000
04 170504 000 000 200 030 095 095	170505 000 000 095 025 090 000	170506 000 000 000 000 000 090	170601 000 000 200 095 095 000
04 170602 000 000 000 000 000 099	170603 000 000 200 085 095 000	170604 000 000 200 030 095 095	170605 000 000 095 025 090 000
04 170606 000 000 000 000 000 090	170701 095 095 090 095 010 000	170702 000 098 075 050 099 000	170703 000 000 200 200 095 095
04 170704 000 000 095 040 098 000	170705 000 000 000 000 000 099	170801 095 095 090 095 110 000	170802 000 098 075 050 099 000
04 170803 000 000 200 200 095 095	170804 000 000 095 040 098 000	170805 000 000 000 000 000 099	170901 035 035 050 090 095 000
04 170902 000 000 000 000 000 099	170903 000 000 200 040 095 000	170904 000 000 200 000 000 099	170905 000 000 080 075 000 000
04 170906 000 000 000 000 000 099	171001 000 000 070 000 000 050	171002 000 000 070 000 000 050	171003 000 000 000 000 000 099
04 171101 000 080 065 070 085 050	171102 000 000 085 000 000 040		

RATER NO. 5

05	010101	097	097	016	043	000	000	010102	097	097	200	200	000	000	010103	000	000	016	043	200	200	010201	000	000	000	013	073	058
05	010202	000	000	016	035	200	067	010301	000	000	073	016	200	000	010302	000	000	200	000	000	000	010303	000	000	200	000	000	000
05	020101	000	000	000	000	034	008	020102	000	000	078	063	061	011	020103	000	000	067	024	039	008	020104	000	000	073	032	043	010
05	020105	000	000	059	019	032	008	020106	000	000	075	035	065	026	020201	000	000	075	000	000	016	020202	000	000	036	000	036	094
05	020203	000	000	073	000	000	016	020204	000	000	073	000	000	016	020205	000	000	079	030	000	000	020301	000	000	084	025	000	000
05	020302	000	000	078	049	023	026	020303	000	000	093	060	043	000	020304	000	000	091	047	045	000	020305	000	000	067	000	072	000
05	030101	000	000	034	200	021	017	030102	000	000	028	200	000	017	030103	000	000	033	102	026	000	030201	000	000	049	027	000	086
05	030202	000	000	056	080	079	000	030203	000	000	046	069	070	000	030301	000	000	026	000	000	043	030302	000	000	016	009	015	000
05	030303	000	000	001	000	000	000	040101	000	000	023	018	023	016	040102	000	000	073	000	000	012	040201	000	000	043	012	030	019
05	040202	000	000	078	091	088	027	040203	000	000	073	030	024	023	040204	000	000	000	046	045	030	040205	000	000	038	073	056	027
05	040206	000	000	033	017	037	018	040207	000	000	023	022	017	022	040208	000	000	046	002	000	033	040209	000	000	000	012	023	019
05	040210	000	000	000	050	059	016	040211	000	000	034	002	035	021	040212	000	000	023	000	000	000	040213	000	000	013	017	039	016
05	040301	000	000	056	025	048	039	040302	000	000	000	002	020	013	040303	000	000	027	000	000	000	040304	000	000	063	000	000	021
05	040401	021	054	012	015	000	000	040402	000	000	014	000	030	200	040403	000	000	000	005	025	018	040404	000	000	000	013	031	016
05	040405	000	000	039	000	035	015	050101	000	000	000	015	023	034	050102	060	000	043	000	049	041	050103	023	057	031	000	000	000
05	050201	000	000	039	000	000	021	050202	000	000	000	053	046	047	050203	000	000	000	014	037	043	050204	000	000	094	083	081	049
05	050301	000	000	069	000	000	049	050302	000	000	001	000	000	000	050303	021	046	002	040	000	000	060101	072	098	043	000	000	000
05	060102	082	096	024	000	000	000	060103	002	000	033	021	024	015	060104	200	000	036	000	000	000	060105	003	000	037	000	009	015
05	060201	000	082	023	000	010	021	060202	000	000	037	031	029	029	060301	000	005	059	000	000	010	060302	000	000	073	000	000	000
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RATER NO. 6

06	010101	090	090	090	090	000	000	010102	090	090	090	090	000	000	010103	000	000	090	090	030	200	010201	000	000	000	090	090	070
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06	130105	000	000	080	080	070	070	130201	000	000	060	000	080	070	130202	000	000	000	080	080	080	130203	000	000	000	000	080	000
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06	171101	000	050	070	090	090	070	171102	000	000	070	000	000	070														

RATER NO. 7

07	010101	055	045	050	065	000	000	010102	045	030	050	065	000	000	010103	000	000	065	065	060	050	010201	000	000	000	085	085	090
07	010202	000	000	080	070	070	090	010301	000	000	070	085	085	000	010302	000	000	060	000	000	000	010303	000	000	060	000	000	000
07	020101	000	000	000	000	075	065	020102	000	000	060	070	075	070	020103	000	000	075	075	075	070	020104	000	000	075	075	075	070
07	020105	000	000	075	075	075	070	020106	000	000	085	065	080	075	020201	000	000	085	000	000	085	020202	000	000	085	000	085	090
07	020203	000	000	085	000	000	090	020204	000	000	085	000	000	090	020205	000	000	085	080	000	000	020301	000	000	090	090	000	000
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07	050201	000	000	050	000	000	065	050202	000	000	000	085	085	075	050203	000	000	000	080	090	090	050204	000	000	050	080	085	075
07	050301	000	000	040	000	000	075	050302	000	000	025	000	000	000	050303	060	040	010	090	000	000	060101	090	095	085	000	000	000
07	060102	090	095	085	000	000	000	060103	090	000	085	090	090	090	060104	065	000	055	000	000	000	060105	040	000	040	000	075	070
07	060201	000	080	085	000	085	085	060202	000	000	085	085	085	085	060301	000	095	090	000	000	090	060302	000	000	090	000	000	000
07	060303	000	000	090	000	000	000	060401	090	085	050	090	000	000	060402	080	075	050	090	000	000	060403	000	080	055	050	060	075
07	060404	050	065	040	000	000	075	060405	000	000	040	000	000	075	060406	050	065	045	000	000	075	060407	000	000	060	085	080	085
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07	090301	000	000	085	080	000	000	090302	000	000	000	070	085	000	090401	000	000	085	000	085	090	090402	000	000	085	000	085	000
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07	110102	000	085	090	090	090	090	110201	000	085	090	090	085	000	110202	000	000	090	000	000	085	110203	000	000	090	000	000	000
07	110204	000	000	088	000	000	000	110301	000	000	090	000	000	000	110302	000	000	090	000	000	000	110303	000	000	090	000	000	000
07	110401	000	000	092	090	000	000	110402	000	000	092	090	000	000	110403	000	000	092	090	000	000	110501	000	000	075	085	090	000
07	110502	000	000	060	000	085	000	110503	070	085	080	085	085	000	120101	050	040	030	050	000	000	120102	000	000	030	000	000	000
07	120103	000	000	000	065	070	080	120104	000	000	045	075	070	090	120105	000	000	060	085	085	000	120106	000	000	060	000	000	000
07	120107	000	000	060	000	000	000	120201	000	000	060	070	070	000	120202	000	000	070	080	080	080	120203	000	000	070	080	075	000
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07	130101	000	000	000	000	085	085	130102	000	000	000	000	080	080	130103	000	000	000	000	085	085	130104	065	060	055	075	000	075
07	130105	000	000	065	080	080	080	130201	000	000	000	000	080	075	130202	000	000	000	090	080	075	130203	000	000	000	000	080	000
07	130301	000	000	000	000	000	060	130302	000	000	050	000	000	070	140101	095	080	090	075	080	099	140102	000	000	000	075	070	080
07	140103	000	000	085	075	000	080	140104	000	000	075	075	090	000	140105	000	000	040	000	000	000	140201	095	085	090	090	090	000
07	140202	000	000	085	085	085	000	140203	000	000	075	080	080	000	140204	000	000	075	075	075	000	140205	000	000	000	000	000	090
07	140301	000	000	055	050	050	090	140302	000	000	000	000	080	090	140303	000	000	045	030	030	000	140304	000	000	000	080	090	095
07	140305	000	000	090	075	085	000	140306	000	000	070	000	000	000	150101	020	020	020	020	020	000	150102	050	070	085	070	070	000
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07	170202	000	000	000	000	000	075	170203	000	000	075	085	090	000	170204	000	000	075	085	090	075	170205	000	000	075	085	090	000
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07	170906	000	000	000	000	000	075	171001	000	000	095	000	000	095	171002	000	000	095	000	000	095	171003	000	000	000	000	000	095
07	171101	000	090	090	090	090	095	171102	000	000	090	000	000	095														

RATER NO. 8

08	010101	090	090	095	095	000	000	010102	035	035	035	050	000	000	010103	000	000	025	025	040	020	010201	000	000	000	060	075	075
08	010202	000	000	085	085	075	085	010301	000	000	095	075	080	000	010302	000	000	085	000	000	000	010303	000	000	095	000	000	000
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08	020105	000	000	075	075	040	065	020106	000	000	090	075	095	070	020201	000	000	065	000	000	090	020202	000	000	095	000	090	099
08	020203	000	000	090	000	000	095	020204	000	000	080	000	000	095	020205	000	000	080	035	000	000	020301	000	000	085	065	000	000
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08	040210	000	000	000	005	090	070	040211	000	000	025	005	075	075	040212	000	000	010	000	000	000	040213	000	000	005	001	005	030
08	040301	000	000	075	065	075	097	040302	000	000	000	005	085	035	040303	000	000	003	000	000	000	040304	000	000	015	000	000	075
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08	040405	000	000	010	000	085	099	050101	000	000	000	005	095	095	050102	025	000	075	000	005	075	050103	010	020	005	000	000	000
08	050201	000	000	085	000	000	095	050202	000	000	000	035	080	055	050203	000	000	000	020	010	085	050204	000	000	030	030	065	080
08	050301	000	000	090	000	000	085	050302	000	000	003	000	000	000	050303	080	075	001	005	000	000	060101	095	085	085	000	000	000
08	060102	095	095	085	000	000	000	060103	002	000	080	065	095	095	060104	001	000	001	000	000	000	060105	080	000	075	000	040	003
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08	060404	075	085	065	000	000	065	060405	000	000	010	000	000	012	060406	075	080	060	000	000	010	060407	000	000	080	005	003	090
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08	070403	060	060	001	060	000	000	070404	000	000	085	085	090	090	080101	000	000	055	000	030	040	080102	000	000	045	055	040	050
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08	080107	000	000	060	065	080	000	080108	085	080	040	065	090	000	080109	035	000	070	075	085	040	080201	000	000	075	080	060	050
08	080202	000	000	080	075	090	000	080203	000	000	085	000	000	000	080204	000	000	030	000	000	000	080205	040	030	045	060	060	000
08	090101	180	180	099	000	000	075	090102	180	180	099	000	000	075	090103	000	000	095	000	000	080	090201	000	000	080	010	001	000
08	090301	000	000	080	010	000	000	090302	000	000	175	005	075	000	090401	000	000	090	000	080	085	090402	000	000	075	000	085	000
08	090501	000	000	060	003	085	000	090502	000	000	005	090	090	000	090503	000	000	095	005	003	090	090504	000	000	075	090	095	040
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08	110102	000	010	010	030	070	060	110201	000	005	040	020	030	000	110202	000	000	030	000	000	025	110203	000	000	035	000	000	000
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08	120103	000	000	000	070	060	075	120104	000	000	035	075	075	075	120105	000	000	080	080	075	000	120106	000	000	020	000	000	000
08	120107	000	000	020	000	000	000	120201	000	000	075	070	075	000	120202	000	000	030	060	060	050	120203	000	000	075	070	070	000
08	120204	000	000	050	075	075	075	120205	000	000	065	075	075	000	120206	000	000	045	030	035	000	120207	000	000	055	030	035	000
08	120301	000	055	070	060	070	000	120302	000	000	075	000	000	000	120303	000	000	010	000	000	000	120304	030	020	050	055	045	000
08	130101	000	000	000	000	005	005	130102	000	000	000	000	095	075	130103	000	000	000	000	085	075	130104	090	090	035	005	000	025
08	130105	000	000	090	080	096	090	130201	000	000	000	000	090	015	130202	000	000	000	[illegible]	030	010	130203	000	000	000	000	075	000
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08	140301	000	000	070	070	075	065	140302	000	000	000	000	090	090	140303	000	000	090	090	085	000	140304	000	000	000	055	065	090
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08	150201	000	000	060	050	080	080	150202	000	000	045	045	070	065	150203	000	000	040	040	070	060	150204	000	000	075	035	080	090
08	150205	000	000	060	045	075	090	150206	000	000	055	050	075	090	160101	030	050	080	065	090	000	160102	000	000	080	060	080	000
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08	170106	000	000	060	000	000	000	170107	050	050	085	080	000	000	170108	000	000	000	000	000	090	170201	000	000	085	075	080	000
08	170202	000	000	000	000	000	085	170203	000	000	085	080	090	000	170204	000	000	085	075	070	085	170205	000	000	085	080	075	000
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08	170304	000	000	085	075	070	085	170305	000	000	085	080	075	000	170306	000	000	000	000	000	090	170401	000	000	085	075	080	000
08	170402	000	000	000	000	000	085	170403	000	000	085	080	090	000	170404	000	000	085	075	070	085	170405	000	000	095	080	075	000
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08	170606	000	000	000	000	000	090	170701	090	090	095	090	080	000	170702	000	099	040	070	095	000	170703	000	000	085	075	085	085
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08	170803	000	000	085	075	085	085	170804	000	000	090	035	015	000	170805	000	000	000	000	000	095	170901	090	080	080	090	090	000
08	170902	000	000	000	000	000	090	170903	000	000	090	080	090	000	170904	000	000	085	000	000	090	170905	000	000	090	075	000	000
08	170906	000	000	000	000	000	090	171001	000	000	085	000	000	085	171002	000	000	085	000	000	090	171003	000	000	000	000	000	095
08	171101	000	065	090	090	095	095	171102	000	000	090	000	000	090														

RATER NO. 9

INCOMPLETE RATINGS-
NOT USED IN DATA ANALYSIS

RATER NO. 10

10	010101 090 090 060 065 000 000	010102 090 095 060 060 000 000	010103 000 000 080 065 070 030	010201 000 000 000 040 095 010
10	010202 000 000 090 030 095 200	010301 000 000 080 030 010 000	010302 000 000 030 000 000 000	010303 000 000 030 000 000 000
10	020101 000 000 000 000 030 090	020102 000 000 085 040 030 070	020103 000 000 085 060 030 075	020104 000 000 075 070 025 080
10	020105 000 000 085 065 040 080	020106 000 000 090 075 025 010	020201 000 000 060 000 000 085	020202 000 000 080 000 020 085
10	020203 000 000 065 000 000 090	020204 000 000 060 000 000 090	020205 000 000 075 040 000 000	020301 000 000 075 035 000 000
10	020302 000 000 070 035 020 090	020303 000 000 099 060 080 000	020304 000 000 099 045 090 000	020305 000 000 080 000 050 000
10	030101 000 000 090 070 080 040	030102 000 000 040 070 000 040	030103 000 000 040 000 080 000	030201 000 000 050 010 000 080
10	030202 000 000 075 070 050 000	030203 000 000 075 080 050 000	030301 000 000 060 000 000 090	030302 000 000 060 070 050 000
10	030303 000 000 010 000 000 000	040101 000 000 085 090 085 040	040102 000 000 095 000 000 010	040201 000 000 075 070 050 060
10	040202 000 000 075 075 040 070	040203 000 000 060 070 040 070	040204 000 000 000 070 040 050	040205 000 000 070 075 050 050
10	040206 000 000 095 080 050 040	040207 000 000 060 080 040 030	040208 000 000 090 040 000 060	040209 000 000 000 075 060 040
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10	040301 000 000 045 030 080 020	040302 000 000 000 040 080 090	040303 000 000 075 000 000 000	040304 000 000 045 000 000 060
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10	060102 095 095 080 000 000 000	060103 080 000 085 050 050 090	060104 070 000 065 000 000 000	060105 090 000 065 000 060 050
10	060201 000 095 075 000 010 085	060202 000 000 065 001 010 090	060301 000 035 090 000 000 085	060302 000 000 090 000 000 000
10	060303 000 000 090 000 000 000	060401 095 095 050 070 000 000	060402 095 095 065 090 000 000	060403 000 020 095 090 020 085
10	060404 095 090 065 000 000 085	060405 000 000 065 000 000 085	060406 090 090 060 000 000 085	060407 000 000 085 050 010 085
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10	070105 000 000 095 080 050 000	070201 000 000 085 070 000 085	070202 000 000 095 000 000 000	070301 000 000 080 080 000 090
10	070302 000 000 095 000 000 090	070303 000 000 095 000 000 090	070401 000 000 050 040 060 090	070402 000 000 030 000 000 000
10	070403 075 075 050 050 000 000	070404 000 000 085 001 050 090	080101 000 000 050 000 095 040	080102 000 000 090 085 095 060
10	080103 000 000 060 055 090 000	080104 000 000 075 075 090 000	080105 000 000 075 085 095 000	080106 000 000 075 085 095 000
10	080107 000 000 070 080 090 000	080108 099 099 065 075 095 000	080109 090 000 065 075 075 040	080201 000 000 090 085 095 040
10	080202 000 000 080 085 090 000	080203 000 000 075 000 000 000	080204 000 000 030 000 000 000	080205 099 090 070 060 040 000
10	090101 000 000 070 000 000 085	090102 000 000 030 000 000 090	090103 000 000 030 000 000 090	090201 000 000 080 040 085 000
10	090301 000 000 085 040 000 000	090302 000 000 000 030 080 000	090401 000 000 085 000 080 090	090402 000 000 085 000 085 000
10	090501 000 000 070 030 080 000	090502 000 000 075 050 085 000	090503 000 000 090 040 085 090	090504 000 000 080 030 060 080
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10	110102 000 060 070 080 090 045	110201 000 070 085 085 090 000	110202 000 000 085 000 000 030	110203 000 000 085 000 000 000
10	110204 000 000 085 000 000 000	110301 000 000 085 000 000 000	110302 000 000 085 000 000 000	110303 000 000 085 000 000 000
10	110401 000 000 095 065 000 000	110402 000 000 095 055 000 000	110403 000 000 095 055 000 000	110501 000 000 060 040 070 000
10	110502 000 000 050 000 070 000	110503 090 060 060 055 075 000	120101 085 090 040 060 000 000	120102 000 000 030 000 000 000
10	120103 000 000 000 035 030 070	120104 000 000 040 040 060 065	120105 000 000 030 030 060 000	120106 000 000 010 000 000 000
10	120107 000 000 010 000 000 000	120201 000 000 080 070 030 000	120202 000 000 040 060 070 065	120203 000 000 040 060 070 000
10	120204 000 000 040 060 070 055	120205 000 000 040 060 070 000	120206 000 000 080 075 075 000	120207 000 000 060 060 030 000
10	120301 000 085 080 075 085 000	120302 000 000 080 000 000 000	120303 000 000 010 000 000 000	120304 099 060 010 040 020 000
10	130101 000 000 000 000 060 080	130102 000 000 000 000 070 080	130103 000 000 000 000 050 085	130104 090 085 050 050 000 070
10	130105 000 000 080 050 060 090	130201 000 000 000 000 060 050	130202 000 000 000 050 040 060	130203 000 000 000 000 075 000
10	130301 000 000 000 000 000 040	130302 000 000 040 000 000 085	140101 085 060 060 085 080 070	140102 000 000 000 055 070 080
10	140103 000 000 040 055 000 200	140104 000 000 040 060 070 000	140105 000 000 040 000 000 000	140201 040 090 090 090 020 000
10	140202 000 000 080 075 060 000	140203 000 000 080 085 060 000	140204 000 000 080 080 060 000	140205 000 000 000 000 000 085
10	140301 000 000 065 075 075 065	140302 000 000 000 000 060 085	140303 000 000 065 030 020 000	140304 000 000 000 030 020 020
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10	150205 000 000 065 080 090 060	150206 000 000 065 080 090 060	160101 090 065 075 085 085 000	160102 000 000 080 085 080 000
10	160103 000 065 085 075 060 000	160201 000 000 085 085 060 000	160202 000 000 085 085 060 000	160203 000 000 085 090 095 060
10	160204 000 000 050 000 000 000	160205 000 000 065 075 060 000	160206 000 000 075 095 095 060	160207 000 000 075 090 095 060
10	160208 000 000 060 000 000 000	160209 000 000 070 085 060 060	160210 000 000 060 000 000 000	170101 085 055 070 080 060 065
10	170102 000 000 070 065 060 055	170103 000 000 060 040 030 000	170104 080 050 200 000 000 000	170105 000 075 070 080 020 090
10	170106 000 000 000 000 000 000	170107 085 075 080 200 000 000	170108 000 000 000 000 000 095	170201 000 000 075 080 020 000
10	170202 000 000 000 000 000 090	170203 000 000 080 075 020 000	170204 000 000 085 030 020 090	170205 000 000 030 040 020 000
10	170206 000 000 000 000 000 085	170301 000 000 075 080 020 000	170302 000 000 000 000 000 090	170303 000 000 080 075 020 000
10	170304 000 000 085 030 020 090	170305 000 000 030 040 020 000	170306 000 000 000 000 000 085	170401 000 000 075 080 020 000
10	170402 000 000 000 000 000 090	170403 000 000 080 075 020 000	170404 000 000 085 030 020 090	170405 000 000 030 040 020 000
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10	170504 000 000 085 030 020 090	170505 000 000 030 040 020 000	170506 000 000 000 000 000 085	170601 000 000 075 080 020 000
10	170602 000 000 000 000 000 090	170603 000 000 080 075 020 000	170604 000 000 085 030 020 090	170605 000 000 030 040 020 000
10	170606 000 000 000 000 000 085	170701 085 085 040 070 030 000	170702 000 060 020 085 040 000	170703 000 000 060 200 060 090
10	170704 000 000 065 075 030 000	170705 000 000 000 000 000 090	170801 095 075 040 080 000 000	170802 000 085 020 085 040 000
10	170803 000 000 060 200 060 090	170804 000 000 065 075 030 000	170805 000 000 000 000 000 090	170901 060 075 060 090 070 000
10	170902 000 000 000 000 000 090	170903 000 000 070 080 020 000	170904 000 000 060 000 000 090	170905 000 000 075 200 000 000
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RATER NO. 11

11	010101	090	080	080	070	000	000	010102	090	080	060	070	000	000	010103	000	000	085	060	080	050	010201	000	000	000	040	095	040
11	010202	000	000	075	050	080	090	010301	000	000	085	050	020	000	010302	000	000	080	000	000	000	010303	000	000	080	000	000	000
11	020101	000	000	000	000	010	001	020102	000	000	060	035	001	020	020103	000	000	060	025	001	040	020104	000	000	070	025	001	020
11	020105	000	000	060	030	001	040	020106	000	000	075	030	001	001	020201	000	000	090	000	000	070	020202	000	000	075	000	020	025
11	020203	000	000	090	000	000	020	020204	000	000	090	000	000	020	020205	000	000	093	020	000	000	020301	000	000	080	020	000	000
11	020302	000	000	090	005	010	001	020303	000	000	080	005	015	000	020304	000	000	095	020	050	000	020305	000	000	099	000	040	000
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11	040210	000	000	000	001	099	050	040211	000	000	090	005	085	075	040212	000	000	001	000	000	000	040213	000	000	001	010	085	060
11	040301	000	000	010	005	095	075	040302	000	000	000	005	099	020	040303	000	000	001	000	000	000	040304	000	000	005	000	000	050
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11	040405	000	000	020	000	080	085	050101	000	000	000	040	095	060	050102	020	000	020	000	060	070	050103	005	050	200	000	000	000
11	050201	000	000	075	000	000	090	050202	000	000	000	020	080	035	050203	000	000	000	020	090	075	050204	000	000	030	045	099	060
11	050301	000	000	070	000	000	010	050302	000	000	040	000	000	000	050303	005	030	005	060	000	000	060101	090	090	085	000	000	000
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11	060404	095	090	060	000	000	050	060405	000	000	075	000	000	085	060406	085	090	020	000	000	050	060407	000	000	080	050	080	085
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11	110401	000	000	095	020	000	000	110402	000	000	095	020	000	000	110403	000	000	095	020	000	000	110501	000	000	050	040	080	000
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11	120107	000	000	050	000	000	000	120201	000	000	090	080	050	000	120202	000	000	080	060	075	065	120203	000	000	060	020	080	000
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11	120301	000	075	070	040	092	000	120302	000	000	080	000	000	000	120303	000	000	030	000	000	000	120304	080	070	001	050	040	000
11	130101	000	000	000	000	080	050	130102	000	000	000	000	090	050	130103	000	000	000	000	099	040	130104	085	080	025	075	000	020
11	130105	000	000	020	010	080	075	130201	000	000	000	000	085	010	130202	000	000	000	040	075	035	130203	000	000	000	000	090	000
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11	140103	000	000	065	070	000	070	140104	000	000	040	060	075	000	140105	000	000	020	000	000	000	140201	030	050	060	080	060	000
11	140202	000	000	060	075	050	000	140203	000	000	020	060	075	000	140204	000	000	020	050	080	000	140205	000	000	000	000	000	080
11	140301	000	000	001	060	090	070	140302	000	000	000	000	090	070	140303	000	000	001	055	070	000	140304	000	000	000	050	080	080
11	140305	000	000	070	060	060	000	140306	000	000	060	000	000	000	150101	060	060	070	060	075	000	150102	060	060	060	050	090	000
11	150201	000	000	065	050	088	070	150202	000	000	020	050	080	070	150203	000	000	020	050	075	070	150204	000	000	035	050	080	070
11	150205	000	000	020	050	080	070	150206	000	000	020	050	070	070	160101	030	060	070	060	085	000	160102	000	000	060	040	060	000
11	160103	000	060	080	050	020	000	160201	000	000	060	060	070	000	160202	000	000	060	060	070	000	160203	000	000	040	062	075	088
11	160204	000	000	050	000	000	000	160205	000	000	020	060	070	000	160206	000	000	080	062	090	085	160207	000	000	040	030	062	070
11	160208	000	000	050	000	000	000	160209	000	000	030	040	080	060	160210	000	000	050	000	000	000	170101	068	085	030	070	088	070
11	170102	000	000	025	070	078	078	170103	000	000	050	030	080	090	170104	040	080	010	000	000	000	170105	000	075	070	030	020	085
11	170106	000	000	020	000	000	000	170107	070	090	078	001	000	000	170108	000	000	000	000	000	085	170201	000	000	060	075	078	000
11	170202	000	000	000	000	000	090	170203	000	000	092	030	085	000	170204	000	000	080	001	095	050	170205	000	000	068	030	030	000
11	170206	000	000	000	000	000	090	170301	000	000	060	075	078	000	170302	000	000	000	000	000	090	170303	000	000	092	030	085	000
11	170304	000	000	080	001	095	050	170305	000	000	068	030	030	000	170306	000	000	000	000	000	090	170401	000	000	060	075	078	000
11	170402	000	000	000	000	000	090	170403	000	000	092	030	085	000	170404	000	000	080	001	095	050	170405	000	000	068	030	030	000
11	170406	000	000	000	000	000	090	170501	000	000	060	075	078	000	170502	000	000	000	000	000	090	170503	000	000	092	030	085	000
11	170504	000	000	080	001	095	050	170505	000	000	068	030	030	000	170506	000	000	000	000	000	090	170601	000	000	060	075	078	000
11	170602	000	000	000	000	000	090	170603	000	000	092	030	085	000	170604	000	000	080	001	095	050	170605	000	000	068	030	030	000
11	170606	000	000	000	000	000	090	170701	090	090	080	075	040	000	170702	000	080	070	060	095	000	170703	000	000	030	060	080	075
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11	170902	000	000	000	000	000	080	170903	000	000	055	040	085	000	170904	000	000	001	000	000	075	170905	000	000	060	060	000	000
11	170906	000	000	000	000	000	085	171001	000	000	099	000	000	080	171002	000	000	059	000	000	050	171003	000	000	000	000	000	099
11	171101	000	030	070	075	080	060	171102	000	000	080	000	000	095														

RATER NO. 12

12	010101	040	036	030	050	000	000	010102	025	030	015	043	000	000	010103	000	000	028	048	045	065	010201	000	000	000	052	051	040
12	010202	000	000	035	050	055	082	010301	000	000	037	030	038	000	010302	000	000	045	000	000	000	010303	000	000	010	000	000	000
12	020101	000	000	000	000	060	040	020102	000	000	050	087	056	050	020103	000	000	060	080	054	058	020104	000	000	045	078	052	060
12	020105	000	000	045	084	052	052	020106	000	000	070	080	057	050	020201	000	000	066	000	000	080	020202	000	000	075	000	050	076
12	020203	000	000	075	000	000	075	020204	000	000	077	000	000	080	020205	000	000	080	080	000	000	020301	000	000	072	075	000	000
12	020302	000	000	082	076	050	078	020303	000	000	080	078	065	000	020304	000	000	080	080	077	000	020305	000	000	078	000	080	000
12	030101	000	000	050	050	070	070	030102	000	000	045	055	000	060	030103	000	000	040	000	055	000	030201	000	000	060	065	000	080
12	030202	000	000	055	070	077	000	030203	000	000	062	072	075	000	030301	000	000	058	000	000	078	030302	000	000	048	074	062	000
12	030303	000	000	035	000	000	000	040101	000	000	087	060	052	052	040102	000	000	085	000	000	055	040201	000	000	060	050	035	068
12	040202	000	000	065	070	038	070	040203	000	000	088	073	040	082	040204	000	000	000	078	040	064	040205	000	000	050	060	037	060
12	040206	000	000	075	066	037	070	040207	000	000	035	062	040	054	040208	000	000	090	070	000	060	040209	000	000	000	060	045	045
12	040210	000	000	000	055	065	056	040211	000	000	090	075	060	072	040212	000	000	025	000	000	000	040213	000	000	060	068	051	070
12	040301	000	000	064	069	062	050	040302	000	000	000	070	064	040	040303	000	000	025	000	000	000	040304	000	000	058	000	000	071
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12	050201	000	000	066	000	000	080	050202	000	000	000	059	081	070	050203	000	000	000	080	070	076	050204	000	000	025	082	083	050
12	050301	000	000	022	000	000	075	050302	000	000	012	000	000	000	050303	040	035	010	075	000	000	060101	089	050	015	000	000	000
12	060102	094	095	015	000	000	000	060103	078	000	074	077	042	075	060104	030	000	010	000	000	000	060105	090	000	040	000	060	082
12	060201	000	060	025	000	050	080	060202	000	000	080	055	052	082	060301	000	045	085	000	000	068	060302	000	000	084	000	000	000
12	060303	000	000	084	000	000	000	060401	080	080	010	065	000	000	060402	095	090	010	071	000	000	060403	000	048	028	080	057	084
12	060404	086	084	015	000	000	065	060405	000	000	032	000	000	075	060406	086	084	032	000	000	067	060407	000	000	038	062	042	076
12	070101	000	000	084	066	062	000	070102	000	000	092	000	000	088	070103	000	000	090	070	056	080	070104	000	000	090	085	000	000
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12	070403	075	035	010	080	000	000	070404	000	000	058	064	080	055	080101	000	000	050	000	070	055	080102	000	000	085	090	074	064
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12	090101	000	000	067	000	000	081	090102	000	000	067	000	000	081	090103	000	000	075	000	000	087	090201	000	000	072	084	055	000
12	090301	000	000	070	086	000	000	090302	000	000	000	070	058	000	090401	000	000	082	000	062	085	090402	000	000	084	000	075	000
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12	090505	000	000	025	000	000	000	090506	000	000	055	065	082	060	090507	000	000	020	000	000	000	110101	000	000	070	065	086	000
12	110102	000	068	068	067	090	047	110201	000	078	071	045	045	000	110202	000	000	075	000	000	035	110203	000	000	070	000	000	000
12	110204	000	000	070	000	000	000	110301	000	000	070	000	000	000	110302	000	000	070	000	000	000	110303	000	000	073	000	000	000
12	110401	000	000	077	072	000	000	110402	000	000	075	072	000	000	110403	000	000	076	072	000	000	110501	000	000	060	058	076	000
12	110502	000	000	048	000	048	000	110503	080	080	050	080	091	000	120101	047	025	020	055	000	000	120102	000	000	025	000	000	000
12	120103	000	000	000	048	065	051	120104	000	000	024	045	069	075	120105	000	000	035	033	040	000	120106	000	000	020	000	000	000
12	120107	000	000	022	000	000	000	120201	000	000	042	050	062	000	120202	000	000	046	052	062	088	120203	000	000	027	035	070	000
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12	120301	000	065	050	055	090	000	120302	000	000	040	000	000	000	120303	000	000	015	000	000	000	120304	082	070	010	060	072	000
12	130101	000	000	000	000	045	060	130102	000	000	000	000	070	050	130103	000	000	000	000	064	070	130104	090	040	020	062	000	052
12	130105	000	000	035	070	074	072	130201	000	000	000	000	065	065	130202	000	000	000	050	056	069	130203	000	000	000	000	060	000
12	130301	000	000	000	000	000	044	130302	000	000	060	000	000	080	140101	015	025	015	077	081	077	140102	000	000	000	045	073	081
12	140103	000	000	027	050	000	090	140104	000	000	030	056	077	000	140105	000	000	030	000	000	000	140201	038	040	036	081	083	000
12	140202	000	000	035	050	067	000	140203	000	000	040	060	074	000	140204	000	000	036	048	076	000	140205	000	000	000	000	000	091
12	140301	000	000	030	065	072	078	140302	000	000	000	000	070	088	140303	000	000	026	052	080	000	140304	000	000	000	050	075	088
12	140305	000	000	050	035	060	000	140306	000	000	042	000	000	000	150101	050	035	025	044	045	000	150102	075	037	028	052	085	000
12	150201	000	000	032	050	082	055	150202	000	000	025	040	080	058	150203	000	000	020	045	080	058	150204	000	000	024	045	082	058
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12	170102	000	000	027	075	077	055	170103	000	000	033	080	064	000	170104	045	035	020	000	000	000	170105	000	038	025	060	055	080
12	170106	000	000	025	000	000	000	170107	030	050	030	035	000	000	170108	000	000	000	000	000	092	170201	000	000	027	058	065	000
12	170202	000	000	000	000	000	090	170203	000	000	032	070	073	000	170204	000	000	033	048	070	089	170205	000	000	030	050	045	000
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12	170906	000	000	000	000	000	087	171001	000	000	036	000	000	094	171002	000	000	050	000	000	097	171003	000	000	000	000	000	091
12	171101	000	040	036	059	079	035	171102	000	000	040	000	000	078														

RATER NO. 13

13	010101	060	060	070	060	000	000	010102	050	050	040	050	000	000	010103	000	000	030	045	050	040	010201	000	000	000	047	055	030
13	010202	000	000	050	030	060	080	010301	000	000	025	010	025	000	010302	000	000	032	000	000	000	010303	000	000	034	000	000	000
13	020101	000	000	000	000	050	050	020102	000	000	030	030	040	040	020103	000	000	040	040	045	045	020104	000	000	035	050	055	035
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13	020203	000	000	047	000	000	037	020204	000	000	067	000	000	070	020205	000	000	075	070	000	175	020301	000	000	085	056	000	155
13	020302	000	000	076	045	030	065	020303	000	000	077	060	085	156	020304	000	000	090	065	090	000	020305	000	000	087	000	087	000
13	030101	000	000	022	020	020	010	030102	000	000	023	015	000	015	030103	000	000	024	000	010	000	030201	000	000	050	025	000	050
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13	040210	000	000	000	060	050	055	040211	000	000	025	070	055	015	040212	000	000	012	000	000	000	040213	000	000	018	013	025	023
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13	040401	050	050	010	009	000	000	040402	000	000	008	000	015	002	040403	000	000	000	025	042	019	040404	000	000	000	007	018	049
13	040405	000	000	011	000	019	051	050101	000	000	000	025	030	020	050102	060	000	050	000	050	050	050103	050	040	020	000	000	000
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13	050301	000	000	030	000	000	065	050302	000	000	018	000	000	000	050303	040	030	015	020	000	000	060101	050	030	080	000	000	000
13	060102	040	035	020	000	000	000	060103	010	000	040	020	030	020	060104	008	000	015	000	000	000	060105	030	000	018	000	020	021
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13	060303	000	000	048	000	000	127	060401	060	040	012	040	000	000	060402	065	043	014	060	000	000	060403	000	060	090	080	070	090
13	060404	055	048	019	000	000	010	060405	000	000	021	000	000	015	060406	053	028	022	000	000	018	060407	000	000	075	050	060	070
13	070101	000	000	020	020	020	000	070102	000	000	040	000	000	060	070103	000	000	030	030	040	070	070104	000	000	050	010	000	000
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13	070403	020	020	003	005	000	000	070404	000	000	080	045	050	085	080101	000	000	030	000	012	020	080102	000	000	070	059	069	050
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13	080202	000	000	031	050	050	000	080203	000	000	010	000	000	000	080204	000	000	008	000	000	000	080205	040	030	020	015	015	000
13	090101	000	000	020	000	000	030	090102	000	000	021	000	000	025	090103	000	000	030	000	000	050	090201	000	000	060	040	015	000
13	090301	000	000	065	030	000	000	090302	000	000	000	035	040	000	090401	000	000	050	000	020	060	090402	000	000	045	000	050	000
13	090501	000	000	080	050	055	000	090502	000	000	070	055	025	000	090503	000	000	075	025	022	015	090504	000	000	085	038	045	035
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13	110102	000	015	060	065	090	050	110201	000	005	030	020	020	000	110202	000	000	015	000	000	045	110203	000	000	020	000	000	000
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13	110401	000	000	031	025	000	000	110402	000	000	032	026	000	000	110403	000	000	035	028	000	000	110501	000	000	040	035	040	000
13	110502	000	000	005	000	010	000	110503	050	050	050	050	050	000	120101	050	050	010	020	000	000	120102	000	000	012	000	000	000
13	120103	000	000	000	030	030	040	120104	000	000	080	085	087	090	120105	000	000	015	010	015	000	120106	000	000	014	000	000	000
13	120107	000	000	013	000	000	000	120201	000	000	020	025	020	000	120202	000	000	011	015	016	010	120203	000	000	016	022	025	000
13	120204	000	000	017	023	024	020	120205	000	030	018	021	023	000	120206	000	000	009	018	014	000	120207	000	000	008	017	010	000
13	120301	000	052	030	032	028	000	120302	000	030	026	000	000	000	120303	000	000	005	000	000	000	120304	048	048	019	016	013	000
13	130101	000	000	000	000	020	050	130102	000	000	000	000	040	060	130103	000	000	000	000	030	055	130104	040	040	010	015	000	015
13	130105	000	000	090	090	085	085	130201	000	000	000	000	035	030	130202	000	000	000	020	034	025	130203	000	000	000	000	025	000
13	130301	000	000	000	000	000	040	130302	000	000	020	000	000	045	140101	030	030	050	060	070	060	140102	000	000	000	010	015	020
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13	140202	000	000	020	040	030	000	140203	000	000	018	030	025	000	140204	000	000	030	017	027	000	140205	000	000	000	000	000	030
13	140301	000	000	021	031	035	040	140302	000	000	000	000	034	035	140303	000	000	025	005	018	000	140304	000	000	000	035	016	025
13	140305	000	000	019	022	036	000	140306	000	000	035	000	000	000	150101	030	030	010	010	020	000	150102	040	025	020	015	025	000
13	150201	000	000	025	018	026	030	150202	000	000	016	017	035	015	150203	000	000	012	011	022	020	150204	000	000	030	020	015	018
13	150205	000	000	014	013	021	017	150206	000	000	015	012	018	022	160101	030	035	010	015	010	000	160102	000	000	011	014	011	000
13	160103	000	030	025	030	015	000	160201	000	000	012	016	012	000	160202	000	000	009	013	009	000	160203	000	000	030	040	050	040
13	160204	000	000	007	000	000	000	160205	000	000	020	035	020	000	160206	000	000	040	050	060	060	160207	000	000	035	045	065	070
13	160208	000	000	005	000	000	000	160209	000	000	018	018	018	030	160210	000	000	017	000	000	000	170101	070	060	030	035	040	015
13	170102	000	000	029	034	030	010	170103	000	000	010	010	011	000	170104	010	020	015	000	000	000	170105	000	025	017	012	012	025
13	170106	000	000	008	000	000	000	170107	020	026	016	013	000	000	170108	000	000	000	000	000	030	170201	000	000	012	014	015	000
13	170202	000	000	000	000	000	027	170203	000	000	014	011	017	000	170204	000	000	011	015	016	022	170205	000	000	013	014	014	000
13	170206	000	000	000	000	000	013	170301	000	000	012	014	015	000	170302	000	000	000	000	000	027	170303	000	000	014	011	017	000
13	170304	000	000	011	015	016	022	170305	000	000	013	014	014	000	170306	000	000	000	000	000	013	170401	000	000	012	014	015	000
13	170402	000	000	000	000	000	027	170403	000	000	014	011	017	000	170404	000	000	011	015	016	022	170405	000	000	013	014	014	000
13	170406	000	000	000	000	000	013	170501	000	000	012	014	015	000	170502	000	000	000	000	000	027	170503	000	000	014	011	017	000
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13	170602	000	000	000	000	000	027	170603	000	000	014	011	017	000	170604	000	000	011	015	016	022	170605	000	000	013	014	014	000
13	170606	000	000	000	000	000	013	170701	050	050	007	026	022	000	170702	000	073	004	015	023	000	170703	000	000	019	022	031	046
13	170704	000	000	018	009	016	000	170705	000	000	000	000	000	027	170801	045	042	023	027	000	000	170802	000	073	004	015	023	000
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13	170902	000	000	000	000	000	038	170903	000	000	044	033	045	000	170904	000	000	006	000	000	011	170905	000	000	028	015	000	113
13	170906	000	000	000	000	000	046	171001	000	000	014	000	000	035	171002	000	000	018	000	000	033	171003	000	000	000	000	000	020
13	171101	000	087	095	096	069	085	171102	000	000	090	000	000	090														

RATER NO. 14

INCOMPLETE RATINGS-
NOT USED IN DATA ANALYSIS

RATER NO. 15

15	010101	075	073	072	072	000	000	010102	073	075	074	073	000	000	010103	000	000	070	070	070	070	010201	000	000	000	075	072	072
15	010202	000	000	077	077	077	075	010301	000	000	073	076	076	000	010302	000	000	071	000	000	000	010303	000	000	069	000	000	000
15	020101	000	000	000	000	055	050	020102	000	000	085	050	057	051	020103	000	000	090	055	056	052	020104	000	000	070	060	048	049
15	020105	000	000	065	052	054	048	020106	000	000	092	075	070	065	020201	000	000	080	000	000	053	020202	000	000	075	000	045	054
15	020203	000	000	072	000	000	055	020204	000	000	078	000	000	060	020205	000	000	093	072	000	000	020301	000	000	088	080	000	000
15	020302	000	000	073	062	059	061	020303	000	000	081	065	080	000	020304	000	000	087	073	079	000	020305	000	000	060	000	072	000
15	030101	000	000	090	088	099	080	030102	000	000	050	055	000	070	030103	000	000	060	000	088	000	030201	000	000	095	090	000	075
15	030202	000	000	088	089	089	000	030203	000	000	089	085	087	000	030301	000	000	091	000	000	077	030302	000	000	087	087	086	000
15	030303	000	000	040	000	000	000	040101	000	000	055	073	085	082	040102	000	000	056	000	000	083	040201	000	000	065	067	084	081
15	040202	000	000	070	070	083	075	040203	000	000	050	052	080	070	040204	000	000	000	066	079	071	040205	000	000	054	071	082	072
15	040206	000	000	060	072	075	074	040207	000	000	072	064	070	069	040208	000	000	071	069	000	073	040209	000	000	000	068	074	068
15	040210	000	000	000	070	081	065	040211	000	000	074	065	071	073	040212	000	000	052	000	000	000	040213	000	000	053	061	078	059
15	040301	000	000	069	062	077	066	040302	000	000	000	060	076	062	040303	000	000	052	000	000	000	040304	000	000	064	000	000	060
15	040401	050	050	051	055	000	000	040402	000	000	049	000	050	050	040403	000	000	000	049	068	076	040404	000	000	000	050	069	077
15	040405	000	000	068	000	071	069	050101	000	000	000	080	079	070	050102	085	000	082	000	085	069	050103	080	070	069	000	000	000
15	050201	000	000	080	000	000	050	050202	000	000	000	082	080	065	050203	000	000	000	079	075	072	050204	000	000	083	082	074	073
15	050301	000	000	084	000	000	071	050302	000	000	070	000	000	000	050303	082	072	068	081	000	000	060101	079	072	085	000	000	000
15	060102	078	070	075	000	000	000	060103	070	000	080	085	080	070	060104	069	000	070	000	000	000	060105	065	000	074	000	050	072
15	060201	000	073	072	000	070	073	060202	000	000	073	080	075	071	060301	000	074	077	000	000	079	060302	000	000	079	000	000	000
15	060303	000	000	078	000	000	000	060401	072	071	065	075	000	000	060402	077	075	070	079	000	000	060403	000	080	069	078	090	075
15	060404	073	069	068	000	000	069	060405	000	000	067	000	000	068	060406	071	070	071	000	000	074	060407	000	000	065	077	082	067
15	070101	000	000	065	070	070	000	070102	000	000	066	000	000	068	070103	000	000	070	072	080	069	070104	000	000	071	073	000	000
15	070105	000	000	069	075	082	000	070201	000	000	072	074	000	071	070202	000	000	073	000	000	000	070301	000	000	074	080	000	075
15	070302	000	000	067	000	000	073	070303	000	000	074	000	000	072	070401	000	000	075	082	085	074	070402	000	000	068	000	000	000
15	070404	000	000	079	078	075	070	070408	075	075	076	076	000	000	080101	000	000	075	000	075	074	080102	000	000	074	080	078	075
15	080103	000	000	076	078	072	000	080104	000	000	077	079	077	000	080105	000	000	078	077	079	000	080106	000	000	073	075	080	000
15	080107	000	000	079	074	074	000	080108	080	077	072	072	071	000	080109	079	000	070	073	073	073	080201	000	000	075	076	076	075
15	080202	000	000	080	081	081	000	080203	000	000	071	000	000	000	080204	000	000	070	000	000	000	080205	081	080	070	075	075	000
15	090101	000	000	080	000	000	065	090102	000	000	079	000	000	064	090103	000	000	090	000	000	070	090201	000	000	089	090	090	000
15	090301	000	000	088	088	000	000	090302	000	000	000	089	089	000	090401	000	000	091	000	091	085	090402	000	000	092	000	092	000
15	090501	000	000	087	085	085	000	090502	000	000	085	084	087	000	090503	000	000	084	082	082	080	090504	000	000	086	086	083	082
15	090505	000	000	077	000	000	000	090506	000	000	082	070	070	083	090507	000	000	065	000	000	000	110101	000	000	076	080	079	000
15	110102	000	078	077	081	080	074	110201	000	077	074	075	077	000	110202	000	000	078	000	000	075	110203	000	000	079	000	000	000
15	110204	000	000	075	000	000	000	110301	000	000	082	000	000	000	110302	000	000	081	000	000	000	110303	000	000	080	000	000	000
15	110401	000	000	083	078	000	000	110402	000	000	085	079	000	000	110403	000	000	084	077	000	000	110501	000	000	073	074	078	000
15	110502	000	000	071	000	076	000	110503	080	079	072	073	075	000	120101	080	073	074	074	000	000	120102	000	000	073	000	000	000
15	120103	000	000	000	079	080	072	120104	000	000	083	078	082	074	120105	000	000	082	080	081	000	120106	000	000	072	000	000	000
15	120107	000	000	071	000	000	000	120201	000	000	084	077	077	000	120202	000	000	077	084	078	073	120203	000	000	080	082	079	000
15	120204	000	000	081	085	083	075	120205	000	000	086	081	084	000	120206	000	000	085	075	085	000	120207	000	000	076	076	076	000
15	120301	000	075	078	083	075	000	120302	000	000	079	000	000	000	120303	000	000	070	000	000	000	120304	075	074	075	073	074	000
15	130101	000	000	000	000	080	030	130102	000	000	000	000	079	079	130103	000	000	000	000	081	081	130104	085	080	080	080	000	082
15	130105	000	000	082	082	082	083	130201	000	000	000	000	070	070	130202	000	000	000	070	065	065	130203	000	000	000	000	071	000
15	130301	000	000	000	000	000	066	130302	000	000	081	000	000	078	140101	069	070	084	085	084	078	140102	000	000	000	080	079	079
15	140103	000	000	074	079	000	074	140104	000	000	079	076	076	000	140105	000	000	075	000	000	000	140201	070	069	085	084	078	000
15	140202	000	000	080	075	077	000	140203	000	000	076	077	080	000	140204	000	000	078	083	085	000	140205	000	000	000	000	000	077
15	140301	000	000	077	078	082	080	140302	000	000	000	000	075	076	140303	000	000	081	082	081	000	140304	000	000	000	074	074	075
15	140305	000	000	083	081	083	000	140306	000	000	082	000	000	000	150101	079	071	085	079	081	000	150102	080	070	078	078	082	000
15	150201	000	000	084	081	084	080	150202	000	000	079	080	079	076	150203	000	000	082	084	082	079	150204	000	000	081	085	083	078
15	150205	000	000	080	082	080	074	150206	000	000	083	083	085	075	160101	080	079	085	084	081	000	160102	000	000	076	075	076	000
15	160103	000	080	079	076	078	000	160201	000	000	078	081	077	000	160202	000	000	084	082	085	000	160203	000	000	083	083	084	080
15	160204	000	000	075	000	000	000	160205	000	000	082	085	083	000	160206	000	000	081	080	082	085	160207	000	000	077	079	079	084
15	160208	000	000	074	000	000	000	160209	000	000	080	078	080	082	160210	000	000	073	000	000	000	170101	069	080	062	064	082	076
15	170102	000	000	063	066	078	073	170103	000	000	061	063	073	000	170104	070	075	066	000	000	000	170105	000	077	069	072	074	069
15	170106	000	000	064	000	000	000	170107	082	076	072	073	000	000	170108	000	000	000	000	000	078	170201	000	000	060	070	070	000
15	170202	000	000	000	000	000	072	170203	000	000	071	071	072	000	170204	000	000	065	065	071	075	170205	000	000	073	075	075	000
15	170206	000	000	000	000	000	071	170301	000	000	060	070	070	000	170302	000	000	000	000	000	072	170303	000	000	071	071	072	000
15	170304	000	000	065	065	071	075	170305	000	000	073	075	075	000	170306	000	000	000	000	000	071	170401	000	000	060	070	070	000
15	170402	000	000	000	000	000	072	170403	000	000	071	071	072	000	170404	000	000	065	065	071	075	170405	000	000	073	075	075	000
15	170406	000	000	000	000	000	071	170501	000	000	060	070	070	000	170502	000	000	000	000	000	072	170503	000	000	071	071	072	000
15	170504	000	000	065	065	071	075	170505	000	000	073	075	075	000	170506	000	000	000	000	000	071	170601	000	000	060	070	070	000
15	170602	000	000	000	000	000	072	170603	000	000	071	071	072	000	170604	000	000	065	065	071	075	170605	000	000	073	075	075	000
15	170606	000	000	000	000	000	071	170701	084	081	080	079	069	000	170702	000	079	076	080	080	000	170703	000	000	079	078	079	077
15	170704	000	000	081	081	081	000	170705	000	000	000	000	000	074	170801	083	078	082	082	000	000	170802	000	079	076	080	080	000
15	170803	000	000	079	078	079	077	170804	000	000	081	081	081	000	170805	000	000	000	000	000	074	170901	068	073	083	084	076	000
15	170902	000	000	000	000	000	079	170903	000	000	085	085	077	000	170904	000	000	069	000	000	080	170905	000	000	084	078	000	000
15	170906	000	000	000	000	000	081	171001	000	000	075	000	000	070	171002	000	000	086	000	000	082	171003	000	000	000	000	000	083
15	171101	000	072	088	088	083	090	171102	000	000	000	000	000	072														

RATER NO. 16

16	010101	076	075	080	074	000	000	010102	076	077	080	078	000	000	010103	000	000	080	080	077	075	010201	000	000	000	078	080	075
16	010202	000	000	079	078	075	080	010301	000	000	080	077	075	000	010302	000	000	079	000	000	000	010303	000	000	080	000	000	000
16	020101	000	000	000	000	070	070	020102	000	000	080	060	080	065	020103	000	000	075	065	065	060	020104	000	000	065	055	045	055
16	020105	000	000	070	050	050	050	020106	000	000	075	060	080	063	020201	000	000	060	000	000	055	020202	000	000	075	000	050	075
16	020203	000	000	070	000	000	078	020204	000	000	075	000	000	080	020205	000	000	080	070	000	000	020301	000	000	085	080	000	000
16	020302	000	000	070	080	060	075	020303	000	000	080	075	090	000	020304	000	000	075	080	080	000	020305	000	000	070	000	085	000
16	030101	000	000	060	065	070	065	030102	000	000	040	050	000	060	030103	000	000	065	000	070	000	030201	000	000	080	085	000	065
16	030202	000	000	070	075	080	000	030203	000	000	075	080	085	000	030301	000	000	080	000	000	070	030302	000	000	075	080	075	000
16	030303	000	000	055	000	000	000	040101	000	000	075	080	070	065	040102	000	000	080	000	000	070	040201	000	000	062	065	070	068
16	040202	000	000	065	070	070	060	040203	000	000	060	063	065	063	040204	000	000	000	065	063	065	040205	000	000	055	060	058	063
16	040206	000	000	058	060	065	063	040207	000	000	050	055	052	045	040208	000	000	075	078	000	080	040209	000	000	000	085	090	080
16	040210	000	000	000	085	090	085	040211	000	000	080	075	085	070	040212	000	000	060	000	000	000	040213	000	000	065	070	065	060
16	040301	000	000	080	070	065	075	040302	000	000	000	075	070	065	040303	000	000	075	000	000	000	040304	000	000	070	000	000	065
16	040401	060	065	070	075	000	000	040402	000	000	060	000	040	050	040403	000	000	000	060	070	065	040404	000	000	000	055	060	050
16	040405	000	000	065	000	055	060	050101	000	000	000	060	050	055	050102	065	000	070	000	055	050	050103	060	065	062	000	000	000
16	050201	000	000	055	000	000	060	050202	000	000	000	085	080	082	050203	000	000	000	085	085	080	050204	000	000	080	085	090	083
16	050301	000	000	085	000	000	075	050302	000	000	045	000	000	000	050303	045	048	045	050	000	000	060101	085	082	080	000	000	000
16	060102	085	082	080	000	000	000	060103	080	000	085	090	075	070	060104	080	000	085	000	000	000	060105	075	000	080	000	050	055
16	060201	000	085	070	000	050	055	060202	000	000	070	080	060	055	060301	000	085	080	000	000	050	060302	000	000	085	000	000	000
16	060303	000	000	082	000	000	000	060401	080	080	085	087	000	000	060402	099	095	099	099	000	000	060403	000	099	099	099	099	099
16	060404	080	085	088	000	000	075	060405	000	000	088	000	000	075	060406	080	075	070	000	000	060	060407	000	000	075	070	060	065
16	070101	000	000	075	080	070	000	070102	000	000	075	000	000	080	070103	000	000	075	080	070	085	070104	000	000	080	085	000	000
16	070105	000	000	080	085	090	000	070201	000	000	085	080	000	075	070202	000	000	075	000	000	000	070301	000	000	085	082	000	080
16	070302	000	000	080	000	000	075	070303	000	000	075	000	000	070	070401	000	000	070	075	080	075	070402	000	000	075	000	000	000
16	070403	080	082	085	075	000	000	070404	000	000	080	085	070	065	080101	000	000	084	000	085	083	080102	000	000	082	086	080	075
16	080103	000	000	085	086	075	000	080104	000	000	086	085	075	000	080105	000	000	085	089	080	000	080106	000	000	085	089	080	000
16	080107	000	000	087	088	089	000	080108	080	082	084	085	083	000	080109	083	000	087	086	082	080	080201	000	000	089	090	085	080
16	080202	000	000	090	089	085	000	080203	000	000	085	000	000	000	080204	000	000	086	000	000	000	080205	080	082	088	090	085	000
16	090101	000	000	080	000	000	075	090102	000	000	075	000	000	070	090103	000	000	070	000	000	080	090201	000	000	080	090	085	000
16	090301	000	000	080	085	000	000	090302	000	000	000	080	085	000	090401	000	000	075	000	080	078	090402	000	000	080	000	088	000
16	090501	000	000	082	085	080	000	090502	000	000	082	085	080	000	090503	000	000	085	087	080	085	090504	000	000	085	088	090	080
16	090505	000	000	075	000	000	000	090506	000	000	070	085	080	075	090507	000	000	070	000	000	000	110101	000	000	085	088	090	000
16	110102	000	080	088	089	090	083	110201	000	082	087	089	088	000	110202	000	000	088	000	000	085	110203	000	000	085	000	000	000
16	110204	000	000	088	000	000	000	110301	000	000	086	000	000	000	110302	000	000	084	000	000	000	110303	000	000	088	000	000	000
16	110401	000	000	087	088	000	000	110402	000	000	085	089	000	000	110403	000	000	083	085	000	000	110501	000	000	087	090	085	000
16	110502	000	000	085	000	084	000	110503	088	090	086	087	085	000	120101	072	075	074	076	000	000	120102	000	000	072	000	000	000
16	120103	000	000	000	080	075	076	120104	000	000	077	080	075	078	120105	000	000	079	080	078	000	120106	000	000	075	000	000	000
16	120107	000	000	077	000	000	000	120201	000	000	077	080	075	000	120202	000	000	077	080	079	076	120203	000	000	079	078	080	000
16	120204	000	000	079	076	080	078	120205	000	000	078	079	080	000	120206	000	000	077	080	078	000	120207	000	000	079	080	077	000
16	120301	000	078	079	081	082	000	120302	000	000	080	000	000	000	120303	000	000	079	000	000	000	120304	076	077	079	080	075	000
16	130101	000	000	000	000	080	085	130102	000	000	000	000	095	080	130103	000	000	000	000	080	085	130104	085	082	080	090	000	075
16	130105	000	000	090	085	082	085	130201	000	000	000	000	090	080	130202	000	000	000	087	080	085	130203	000	000	000	000	075	000
16	130301	000	000	000	000	000	080	130302	000	000	085	000	000	075	140101	060	062	064	065	060	063	140102	000	000	000	065	060	066
16	140103	000	000	064	065	000	060	140104	000	000	064	065	066	000	140105	000	000	064	000	000	000	140201	060	062	065	066	064	000
16	140202	000	000	063	064	065	000	140203	000	000	064	065	066	000	140204	000	000	066	065	064	000	140205	000	000	000	000	000	063
16	140301	000	000	065	066	062	064	140302	000	000	000	000	062	064	140303	000	000	065	066	064	000	140304	000	000	000	066	063	065
16	140305	000	000	066	067	062	000	140306	000	000	065	000	000	000	150101	070	071	073	075	072	000	150102	071	072	073	075	074	000
16	150201	000	000	075	076	077	074	150202	000	000	077	075	076	074	150203	000	000	074	075	073	072	150204	000	000	073	074	075	072
16	150205	000	000	073	074	075	072	150206	000	000	073	074	075	072	160101	088	089	090	091	090	000	160102	000	000	090	092	091	000
16	160103	000	089	091	092	090	000	160201	000	000	089	090	090	000	160202	000	000	090	091	089	000	160203	000	000	090	092	091	089
16	160204	000	000	092	000	000	000	160205	000	000	091	093	092	000	160206	000	000	092	093	091	092	160207	000	000	091	092	093	090
16	160208	000	000	090	000	000	000	160209	000	000	092	093	090	091	160210	000	000	090	000	000	000	170101	072	073	074	077	076	075
16	170102	000	000	074	076	075	073	170103	000	000	074	075	076	000	170104	072	073	074	000	000	000	170105	000	074	075	077	073	074
16	170106	000	000	073	000	000	000	170107	072	073	074	075	000	000	170108	000	000	000	000	000	072	170201	000	000	075	076	074	000
16	170202	000	000	000	000	000	073	170203	000	000	073	074	075	000	170204	000	000	073	076	075	074	170205	000	000	074	075	073	000
16	170206	000	000	000	000	000	072	170301	000	000	075	076	074	000	170302	000	000	000	000	000	073	170303	000	000	073	074	075	000
16	170304	000	000	073	076	075	074	170305	000	000	074	075	073	000	170306	000	000	000	000	000	072	170401	000	000	075	076	074	000
16	170402	000	000	000	000	000	073	170403	000	000	073	074	075	000	170404	000	000	073	076	075	074	170405	000	000	074	075	073	000
16	170406	000	000	000	000	000	072	170501	000	000	075	076	074	000	170502	000	000	000	000	000	073	170503	000	000	073	074	075	000
16	170504	000	000	073	076	075	074	170505	000	000	074	075	073	000	170506	000	000	000	000	000	072	170601	000	000	075	076	074	000
16	170602	000	000	000	000	000	073	170603	000	000	073	074	075	000	170604	000	000	073	076	075	074	170605	000	000	074	075	073	000
16	170606	000	000	000	000	000	072	170701	074	075	076	077	073	000	170702	000	074	075	077	076	000	170703	000	000	077	076	074	073
16	170704	000	000	076	077	075	000	170705	000	000	000	000	000	072	170801	074	075	076	077	000	000	170802	000	074	075	077	076	000
16	170803	000	000	077	076	074	073	170804	000	000	076	077	075	000	170805	000	000	000	000	000	072	170901	070	071	074	076	075	000
16	170902	000	000	000	000	000	072	170903	000	000	074	076	075	000	170904	000	000	074	000	000	073	170905	000	000	075	076	000	000
16	170906	000	000	000	000	000	072	171001	000	000	075	000	000	074	171002	000	000	076	000	000	075	171003	000	000	000	000	000	073
16	171101	000	074	075	077	076	073	171102	000	000	075	000	000	074														

RATER NO. 17

17	010101	020	040	040	020	000	000	010102	020	020	040	040	000	000	010103	000	000	020	020	040	040	010201	000	000	000	040	040	020
17	010202	000	000	020	040	040	020	010301	000	000	040	020	020	000	010302	000	000	040	000	000	000	010303	000	000	060	000	000	000
17	020101	000	000	120	000	080	010	020102	000	000	010	010	020	080	020103	000	000	020	010	080	010	020104	000	000	010	010	060	060
17	020105	000	000	020	010	010	050	020106	000	000	040	010	010	010	020201	000	000	040	000	000	010	020202	000	000	040	000	010	080
17	020203	000	000	060	000	000	020	020204	000	000	040	000	000	080	020205	000	000	060	010	000	180	020301	000	000	040	010	000	180
17	020302	000	000	040	010	010	060	020303	000	000	040	010	060	000	020304	000	000	020	040	040	000	020305	000	000	040	000	060	000
17	030101	000	000	010	010	040	040	030102	000	000	020	010	000	040	030103	000	000	010	000	010	000	030201	000	000	060	010	000	060
17	030202	000	000	080	010	010	000	030203	000	000	080	010	010	000	030301	000	000	010	000	000	010	030302	000	000	040	010	010	000
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17	040206	000	120	020	010	020	030	040207	000	000	040	010	010	040	040208	000	000	080	010	000	010	040209	000	000	000	010	080	010
17	040210	000	000	110	200	080	010	040211	000	000	030	020	040	010	040212	000	000	040	120	140	000	040213	000	000	040	020	020	020
17	040301	000	000	030	020	020	020	040302	000	000	120	020	040	010	040303	000	000	080	000	120	000	040304	000	000	080	000	000	020
17	040401	010	010	040	040	000	000	040402	000	000	090	000	200	200	040403	000	000	120	010	040	030	040404	000	000	120	030	040	010
17	040405	000	000	060	000	020	020	050101	000	000	120	010	050	020	050102	010	000	030	000	030	020	050103	010	010	020	000	000	120
17	050201	000	000	020	120	120	010	050202	000	000	000	020	040	010	050203	000	000	000	040	040	020	050204	000	000	020	020	020	020
17	050301	000	000	080	000	000	020	050302	000	000	040	000	000	000	050303	010	010	060	020	000	000	060101	010	010	040	120	110	010
17	060102	010	010	040	120	110	110	060103	200	000	040	040	010	010	060104	200	000	040	140	120	000	060105	010	000	040	000	040	010
17	060201	000	030	030	000	030	010	060202	000	000	030	030	030	010	060301	000	200	030	000	130	010	060302	000	000	030	000	130	000
17	060303	000	000	040	000	130	000	060401	010	010	030	040	000	000	060402	010	010	030	030	000	000	060403	000	200	030	020	030	010
17	060404	010	010	040	000	000	010	060405	000	000	030	000	130	010	060406	010	010	010	000	000	005	060407	000	000	020	020	040	010
17	070101	000	000	020	010	020	000	070102	000	000	020	000	120	020	070103	000	000	020	010	020	010	070104	000	000	040	010	140	000
17	070105	000	000	030	020	030	000	070201	000	000	020	020	120	010	070202	000	000	040	020	120	000	070301	000	000	020	020	000	010
17	070302	000	000	020	000	000	010	070303	000	000	020	000	010	020	070401	000	000	040	020	010	010	070402	000	000	030	000	000	000
17	070403	010	010	020	020	110	000	070404	000	000	020	010	020	010	080101	000	000	060	000	060	010	080102	000	000	040	060	060	010
17	080103	000	000	040	040	020	000	080104	000	000	040	040	020	000	080105	000	000	020	040	040	000	080106	000	000	040	040	020	000
17	080107	000	000	020	020	060	000	080108	020	020	010	020	040	000	080109	010	000	020	020	060	010	080201	000	000	040	020	060	010
17	080202	000	000	040	040	040	000	080203	000	000	060	000	000	000	080204	000	000	060	000	000	000	080205	010	010	020	040	020	000
17	090101	000	000	040	000	120	200	090102	000	000	040	000	120	200	090103	000	000	040	000	120	200	090201	000	000	040	010	040	000
17	090301	000	000	040	020	000	000	090302	000	000	000	010	020	000	090401	000	000	030	000	030	010	090402	000	000	020	000	010	000
17	090501	000	000	010	010	030	000	090502	000	000	020	020	020	000	090503	000	000	030	010	030	010	090504	000	000	040	010	040	010
17	090505	000	000	040	000	000	000	090506	000	000	020	010	030	010	090507	000	000	020	000	000	000	110101	000	000	040	040	010	000
17	110102	000	010	030	020	040	010	110201	000	010	060	020	020	000	110202	000	000	040	000	000	010	110203	000	000	040	000	000	000
17	110204	000	000	040	000	000	000	110301	000	000	040	000	000	000	110302	000	000	040	000	000	000	110303	000	000	040	000	000	000
17	110401	000	000	040	020	000	000	110402	000	000	040	020	000	000	110403	000	000	040	020	000	000	110501	000	000	040	020	020	000
17	110502	000	000	040	000	020	000	110503	010	020	010	020	020	000	120101	030	010	040	020	000	000	120102	000	000	040	000	000	000
17	120103	000	000	000	020	040	010	120104	000	000	020	040	040	040	120105	000	000	020	020	020	000	120106	000	000	040	000	000	000
17	120107	000	000	040	000	000	000	120201	000	000	060	020	010	000	120202	000	000	040	020	020	010	120203	000	000	020	020	040	000
17	120204	000	000	020	020	030	010	120205	000	000	020	020	040	000	120206	000	000	040	020	010	000	120207	000	000	060	010	010	000
17	120301	000	010	020	020	040	000	120302	000	000	050	000	000	000	120303	000	000	020	000	000	000	120304	040	040	020	020	010	000
17	130101	000	120	000	120	020	010	130102	000	000	000	000	040	010	130103	000	120	120	000	020	010	130104	010	010	020	020	000	010
17	130105	000	000	040	010	040	010	130201	000	000	000	000	030	010	130202	000	000	000	010	010	010	130203	000	000	000	000	010	000
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17	140103	000	000	040	040	000	020	140104	000	000	040	040	020	000	140105	000	000	040	000	000	000	140201	010	020	040	010	020	000
17	140202	000	000	020	020	020	000	140203	000	000	020	020	040	000	140204	000	000	040	020	020	000	140205	000	000	000	000	000	060
17	140301	000	000	020	020	040	010	140302	000	000	000	000	040	040	140303	000	000	020	020	020	000	140304	000	000	000	030	030	020
17	140305	000	000	040	020	020	000	140306	000	000	040	000	000	000	150101	020	010	040	020	020	000	150102	020	020	030	030	040	000
17	150201	000	000	020	020	040	010	150202	000	000	040	020	040	010	150203	000	000	020	020	040	010	150204	000	000	030	020	040	010
17	150205	000	000	030	020	040	010	150206	000	000	040	020	040	010	160101	010	010	010	030	030	000	160102	000	000	020	020	020	000
17	160103	000	010	030	020	020	000	160201	000	000	020	020	040	000	160202	000	000	020	020	040	000	160203	000	000	020	010	020	010
17	160204	000	000	070	000	000	000	160205	000	000	040	010	020	000	160206	000	000	040	030	040	010	160207	000	000	040	020	040	020
17	160208	000	000	060	000	000	000	160209	000	000	050	020	020	010	160210	000	000	060	000	000	000	170101	010	010	030	030	030	010
17	170102	000	000	030	020	030	010	170103	000	000	030	020	040	000	170104	010	040	020	000	000	000	170105	000	030	050	020	010	010
17	170106	000	000	050	000	000	000	170107	010	010	040	010	000	000	170108	000	000	000	000	000	060	170201	000	000	040	020	020	000
17	170202	000	000	000	000	000	050	170203	000	000	040	020	040	000	170204	000	000	030	020	040	010	170205	000	000	040	010	020	000
17	170206	000	000	000	000	000	040	170301	000	000	040	020	020	000	170302	000	000	000	000	000	050	170303	000	000	040	020	040	000
17	170304	000	000	030	020	040	010	170305	000	000	040	010	020	000	170306	000	000	000	000	000	040	170401	000	000	040	020	020	000
17	170402	000	000	000	000	000	050	170403	000	000	040	020	040	000	170404	000	000	030	020	040	010	170405	000	000	040	010	020	030
17	170406	000	000	000	000	000	040	170501	000	000	040	020	020	000	170502	000	000	000	000	000	050	170503	000	000	040	020	040	000
17	170504	000	000	030	020	040	010	170505	000	000	040	010	020	000	170506	000	000	000	000	000	040	170601	000	000	040	020	020	000
17	170602	000	000	000	000	000	050	170603	000	000	040	020	040	000	170604	000	000	030	020	040	010	170605	000	000	040	010	020	000
17	170606	000	000	000	000	000	040	170701	020	010	010	030	040	000	170702	000	020	010	010	040	000	170703	000	000	020	010	020	030
17	170704	000	000	030	010	010	000	170705	000	000	000	000	000	050	170801	020	020	010	030	000	000	170802	000	020	010	010	040	000
17	170803	000	000	020	010	020	030	170804	000	000	030	010	010	000	170805	000	000	000	000	000	050	170901	020	010	020	020	010	000
17	170902	000	000	000	000	000	040	170903	000	000	030	010	020	000	170904	000	000	030	000	000	010	170905	000	000	030	020	000	000
17	170906	000	000	000	000	000	050	171001	000	000	040	000	000	040	171002	000	000	050	000	000	030	171003	000	000	000	000	000	080
17	171101	000	010	030	050	030	010	171102	000	000	040	000	000	030														

RATER NO. 18

18	010101	020	020	030	030	000	000	010102	020	020	030	030	000	000	010103	000	000	020	030	040	030	010201	000	000	000	010	020	010
18	010202	000	000	020	030	030	020	010301	000	000	030	020	020	000	010302	000	000	030	000	000	000	010303	000	000	020	000	000	000
18	020101	000	000	000	000	070	030	020102	000	000	030	020	040	020	020103	000	000	020	040	040	030	020104	000	000	020	030	040	030
18	020105	000	000	030	030	030	040	020106	000	000	060	070	080	070	020201	000	000	020	000	000	030	020202	000	000	020	000	040	060
18	020203	000	000	020	000	000	020	020204	000	000	030	000	000	020	020205	000	000	050	040	000	000	020301	000	000	040	030	000	000
18	020302	000	000	030	040	050	030	020303	000	000	040	040	060	000	020304	000	000	040	030	060	000	020305	000	000	060	000	080	000
18	030101	000	000	040	040	050	030	030102	000	000	010	005	000	005	030103	000	000	010	000	015	000	030201	000	000	070	040	000	030
18	030202	000	000	050	060	050	000	030203	000	000	050	060	050	000	030301	000	000	030	000	000	010	030302	000	000	020	010	010	000
18	030303	000	000	010	000	000	000	040101	000	000	020	010	010	005	040102	000	000	020	000	000	005	040201	000	000	015	010	005	005
18	040202	000	000	030	030	020	010	040203	000	000	050	050	030	030	040204	000	000	000	040	040	020	040205	000	000	020	010	020	200
18	040206	000	000	010	015	010	005	040207	000	000	010	005	010	200	040208	000	000	060	020	000	030	040209	000	000	000	020	040	020
18	040210	000	000	000	030	030	200	040211	000	000	060	070	060	050	040212	000	000	020	000	000	000	040213	000	000	020	010	010	005
18	040301	000	000	060	060	050	020	040302	000	000	000	050	050	020	040303	000	000	020	000	000	000	040304	000	000	030	000	000	040
18	040401	020	030	010	010	000	000	040402	000	000	010	000	005	005	040403	000	000	000	040	040	040	040404	000	000	000	020	020	010
18	040405	000	000	040	000	050	050	050101	000	000	000	060	060	010	050102	030	000	040	000	040	010	050103	030	030	040	000	000	000
18	050201	000	000	060	000	000	060	050202	000	000	000	040	045	025	050203	000	000	000	060	070	025	050204	000	000	040	030	030	010
18	050301	000	000	030	000	000	020	050302	000	000	020	000	000	000	050303	030	030	040	040	000	000	060101	030	030	040	000	000	000
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18	060303	000	000	080	000	000	000	060401	080	070	080	060	000	000	060402	080	070	050	040	000	000	060403	000	080	080	060	050	080
18	060404	030	040	040	000	000	040	060405	000	000	040	000	000	040	060406	030	040	040	000	000	040	060407	000	000	060	070	060	050
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18	070302	000	000	070	000	000	070	070303	000	000	070	000	000	070	070401	000	000	075	075	060	070	070402	000	000	050	000	000	000
18	070403	030	030	040	060	000	000	070404	000	000	040	060	050	060	080101	000	000	030	000	040	030	080102	000	000	070	070	080	040
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18	080202	000	000	070	080	080	000	080203	000	000	040	000	000	000	080204	000	000	030	000	000	000	080205	020	030	030	050	050	000
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18	110102	000	070	080	090	090	080	110201	000	070	080	090	090	000	110202	000	000	070	000	000	060	110203	000	000	060	000	000	000
18	110204	000	000	040	000	000	000	110301	000	000	040	000	000	000	110302	000	000	040	000	000	000	110303	000	000	040	000	000	000
18	110401	000	000	040	040	000	000	110402	000	000	040	040	000	000	110403	000	000	040	040	000	000	110501	000	000	040	040	030	000
18	110502	000	000	030	000	020	000	110503	030	030	040	050	040	000	120101	020	020	030	030	000	000	120102	000	000	020	000	000	000
18	120103	000	000	060	030	020	020	120104	000	000	050	050	040	020	120105	000	000	030	030	020	000	120106	000	000	030	000	000	000
18	120107	000	000	030	000	000	000	120201	000	000	030	030	020	000	120202	000	000	030	020	020	020	120203	000	000	030	020	020	000
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18	130105	000	000	040	040	030	015	130201	000	000	000	000	020	010	130202	000	000	000	020	020	015	130203	000	000	000	000	020	000
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18	150201	000	000	030	030	040	030	150202	000	000	020	020	020	020	150203	000	000	020	020	030	020	150204	000	000	030	020	020	030
18	150205	000	000	030	030	020	020	150206	000	000	020	020	020	010	160101	030	030	070	070	060	000	160102	000	000	070	070	050	000
18	160103	000	030	060	060	060	000	160201	000	000	060	060	050	000	160202	000	000	060	060	050	000	160203	000	000	060	060	050	050
18	160204	000	000	050	000	000	000	160205	000	000	040	040	050	000	160206	000	000	070	070	080	070	160207	000	000	040	040	050	030
18	160208	000	000	030	000	000	000	160209	000	000	040	040	030	030	160210	000	000	030	000	000	000	170101	030	030	040	030	020	020
18	170102	000	000	030	020	020	010	170103	000	000	030	020	020	000	170104	030	030	040	000	000	000	170105	000	030	040	040	030	050
18	170106	000	000	030	000	000	000	170107	040	040	050	040	000	000	170108	000	000	000	000	000	050	170201	000	000	020	030	020	000
18	170202	000	000	000	000	030	040	170203	000	000	030	030	020	000	170204	000	000	030	030	020	020	170205	000	000	030	030	040	000
18	170206	000	000	000	000	000	050	170301	000	000	030	030	020	000	170302	000	000	000	000	000	040	170303	000	000	030	030	020	000
18	170304	000	000	030	030	020	020	170305	000	000	030	030	040	000	170306	000	000	000	000	000	050	170401	000	000	030	030	020	000
18	170402	000	000	000	000	000	040	170403	000	000	030	030	020	000	170404	000	000	030	030	020	020	170405	000	000	030	030	040	000
18	170406	000	000	000	000	000	050	170501	000	000	030	030	020	000	170502	000	000	000	000	000	040	170503	000	000	030	030	020	000
18	170504	000	000	030	030	020	020	170505	000	000	030	030	040	000	170506	000	000	000	000	000	050	170601	000	000	030	030	020	000
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18	170606	000	000	000	000	000	050	170701	030	060	040	040	050	000	170702	000	040	030	030	030	000	170703	000	000	030	030	030	040
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18	170902	000	000	000	000	000	030	170903	000	000	040	040	030	000	170904	000	000	030	000	000	030	170905	000	000	040	040	000	000
18	170906	000	000	000	000	000	030	171001	000	000	020	000	000	020	171002	000	000	060	000	000	060	171003	000	000	000	000	000	060
18	171101	000	050	070	070	060	060	171102	000	000	070	000	000	070														

RATER NO. 19

19	010101	020	020	090	030	000	000	010102	035	020	070	030	090	000	010103	000	000	075	040	080	020	010201	000	000	000	080	080	010
19	010202	000	000	090	090	090	070	010301	000	000	070	070	090	000	010302	000	000	090	000	000	000	010303	000	000	090	000	000	000
19	020101	000	000	000	000	090	060	020102	000	000	080	040	060	030	020103	000	000	040	040	070	040	020104	000	000	090	060	070	040
19	020105	000	000	060	030	070	030	020106	000	000	060	060	080	070	020201	000	000	090	000	000	090	020202	000	000	090	000	095	090
19	020203	000	000	090	000	000	090	020204	000	000	090	000	000	090	020205	000	000	040	040	000	000	020301	000	000	070	070	000	000
19	020302	000	000	060	040	080	020	020303	000	000	070	030	090	000	020304	000	000	090	070	099	000	020305	000	000	070	000	099	000
19	030101	000	000	050	050	090	091	030102	000	000	080	080	000	080	030103	000	000	030	000	030	000	030201	000	000	099	099	000	099
19	030202	000	000	095	095	097	000	030203	000	000	080	080	085	000	030301	000	000	070	000	000	080	030302	000	000	050	050	060	000
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19	040206	000	000	030	031	040	030	040207	000	000	030	031	032	030	040208	000	000	070	071	000	050	040209	000	000	000	040	045	040
19	040210	000	000	000	030	030	030	040211	000	000	070	080	090	070	040212	000	000	080	000	000	000	040213	000	000	075	080	085	070
19	040301	000	000	070	071	073	070	040302	000	000	000	070	080	071	040303	000	000	099	000	000	000	040304	000	000	080	000	000	080
19	040401	040	040	060	065	000	000	040402	000	000	099	000	099	099	040403	000	000	000	080	085	080	040404	000	000	000	060	090	060
19	040405	000	000	080	000	099	050	050101	000	000	000	080	090	080	050102	090	000	090	000	090	090	050103	099	099	099	000	000	000
19	050201	000	000	090	000	000	090	050202	000	000	000	090	095	080	050203	000	000	000	080	085	080	050204	000	000	090	090	099	090
19	050301	000	000	095	000	000	090	050302	000	000	070	000	000	000	050303	070	070	080	085	000	000	060101	099	095	080	000	000	000
19	060102	095	070	096	000	000	000	060103	099	000	090	095	099	080	060104	099	000	095	000	000	000	060105	099	000	099	000	099	080
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19	060303	000	000	080	000	000	000	060401	090	090	080	090	000	000	060402	099	099	099	099	000	000	060403	000	099	099	099	099	095
19	060404	095	096	097	000	000	095	060405	000	000	095	000	000	095	060406	099	099	099	000	000	097	060407	000	000	099	099	099	099
19	070101	000	000	070	070	075	000	070102	000	000	070	000	000	065	070103	000	000	070	075	085	085	070104	000	000	090	090	000	000
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19	070302	000	000	040	000	000	040	070303	000	000	040	000	000	040	070401	000	000	060	065	079	075	070402	000	000	099	000	000	000
19	070403	080	090	085	090	000	000	070404	000	000	080	085	090	085	080101	000	000	080	000	090	020	080102	000	000	080	080	090	020
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19	080202	000	000	080	090	080	000	080203	000	000	040	000	000	000	080204	000	000	050	000	000	000	080205	090	070	090	080	080	000
19	090101	000	000	080	000	000	075	090102	000	000	080	000	000	075	090103	000	000	085	000	000	080	090201	000	000	080	085	090	000
19	090301	000	000	075	075	000	000	090302	030	000	000	070	075	000	090401	000	000	075	000	085	075	090402	000	000	080	000	085	000
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19	110102	000	090	090	090	090	040	110201	000	090	090	090	090	000	110202	000	000	090	000	000	020	110203	000	000	099	000	000	000
19	110204	000	000	099	000	000	000	110301	000	000	099	000	000	000	110302	000	000	099	000	000	000	110303	000	000	099	000	000	000
19	110401	000	000	099	099	000	000	110402	000	000	099	099	000	000	110403	000	000	099	099	000	000	110501	000	000	070	070	070	000
19	110502	000	000	060	000	060	000	110503	090	080	090	080	090	000	120101	090	020	070	080	000	000	120102	000	000	020	000	000	000
19	120103	000	000	000	080	080	020	120104	000	000	090	080	080	020	120105	000	000	099	060	080	000	120106	000	000	070	000	000	000
19	120107	000	000	060	000	000	000	120201	000	000	080	070	060	090	120202	000	000	070	070	070	020	120203	000	000	070	070	070	000
19	120204	000	000	040	030	040	010	120205	000	000	060	060	070	000	120206	000	000	050	050	060	000	120207	000	000	070	070	040	000
19	120301	000	040	070	060	075	000	120302	000	000	080	000	000	000	120303	000	000	080	000	000	000	120304	080	070	075	075	080	000
19	130101	000	000	000	000	070	065	130102	000	000	000	000	075	070	130103	000	000	000	000	075	070	130104	090	090	090	090	000	090
19	130105	000	000	090	095	099	095	130201	000	000	000	000	095	090	130202	000	000	000	080	080	080	130203	000	000	000	000	070	000
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19	140103	000	000	070	060	000	060	140104	000	000	060	070	060	000	140105	000	000	099	000	000	000	140201	020	010	050	050	050	000
19	140202	000	000	040	040	060	000	140203	000	000	040	050	080	000	140204	000	000	050	060	090	000	140205	000	000	000	000	000	070
19	140301	000	000	070	070	070	020	140302	000	000	000	000	090	001	140303	000	000	070	060	080	000	140304	000	000	000	030	070	030
19	140305	000	000	070	070	070	000	140306	000	000	065	000	000	000	150101	010	010	090	070	060	000	150102	030	020	060	060	090	000
19	150201	000	000	090	080	080	030	150202	000	000	080	070	080	070	150203	000	000	070	070	080	020	150204	000	000	080	080	090	020
19	150205	000	000	080	080	090	020	150206	000	000	070	075	080	050	160101	080	070	090	070	095	000	160102	000	000	099	030	080	000
19	160103	000	030	080	060	080	000	160201	000	000	070	050	090	000	160202	000	000	070	040	090	000	160203	000	000	070	040	090	030
19	160204	000	000	050	000	000	000	160205	000	000	080	060	070	000	160206	000	000	090	040	080	040	160207	000	000	080	070	090	040
19	160208	000	000	070	000	000	000	160209	000	000	060	070	080	050	160210	000	000	020	000	000	000	170101	060	020	080	070	090	020
19	170102	000	000	090	070	070	020	170103	000	000	090	080	090	000	170104	040	040	060	000	000	000	170105	000	040	080	070	080	030
19	170106	000	000	080	000	000	000	170107	070	020	080	070	000	000	170108	000	000	000	000	000	099	170201	000	000	080	070	060	000
19	170202	000	000	000	000	000	060	170203	000	000	080	070	070	000	170204	000	000	080	070	070	030	170205	000	000	080	070	070	000
19	170266	000	000	000	000	000	085	170301	000	000	080	070	060	000	170302	000	000	000	000	000	060	170303	000	000	080	070	070	000
19	170304	000	000	080	070	070	030	170305	000	000	080	070	070	000	170306	000	000	000	000	000	085	170401	000	000	080	070	060	000
19	170402	000	000	000	000	000	060	170403	000	000	080	070	070	000	170404	000	000	080	070	070	030	170405	000	000	080	070	070	000
19	170406	000	000	000	000	000	085	170501	000	000	080	070	060	000	170502	000	000	000	000	000	060	170503	000	000	080	070	070	000
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19	170606	000	000	000	000	000	085	170701	080	030	060	080	060	000	170702	000	030	070	090	070	000	170703	000	000	060	080	060	030
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19	170902	000	000	000	000	000	030	170903	030	000	080	070	070	000	170904	000	000	060	000	000	040	170905	000	000	060	060	000	000
19	170906	000	000	000	000	000	060	171001	000	000	060	070	000	070	171002	000	000	070	000	000	040	171003	000	000	000	030	000	080
19	171101	000	020	070	070	070	020	171102	000	000	050	000	000	050														

RATER NO. 20

20	010101	040	040	040	040	000	000	010102	080	080	080	070	000	000	010103	000	000	070	060	060	080	010201	000	000	000	060	060	070
20	010202	000	000	040	040	050	050	010301	000	000	050	050	050	000	010302	000	000	050	000	000	000	010303	000	000	075	000	000	000
20	020101	000	000	000	000	040	010	020102	000	000	030	025	020	015	020103	000	000	020	010	010	005	020104	000	000	020	015	010	005
20	020105	000	000	030	015	010	005	020106	000	000	060	035	075	030	020201	000	000	040	000	000	010	020202	000	000	020	000	015	010
20	020203	000	000	030	000	000	010	020204	000	000	030	000	000	010	020205	000	000	050	025	000	000	020301	000	000	030	020	000	000
20	020302	000	000	040	025	040	025	020303	000	000	045	020	040	000	020304	000	000	040	010	040	000	020305	000	000	035	000	060	000
20	030101	000	000	035	015	040	025	030102	000	000	010	010	000	010	030103	000	000	010	000	010	000	030201	000	000	025	015	000	020
20	030202	000	000	025	015	040	000	030203	000	000	030	015	020	000	030301	000	000	015	000	000	020	030302	000	000	015	010	010	000
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20	040210	000	000	000	015	020	020	040211	000	000	010	015	020	020	040212	000	000	010	000	000	000	040213	000	000	010	010	010	010
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20	040401	010	010	010	010	000	000	040402	000	000	005	000	005	005	040403	000	000	000	020	025	020	040404	000	000	000	020	020	020
20	040405	000	000	020	000	015	015	050101	000	000	000	010	010	010	050102	090	000	090	000	090	090	050103	080	095	075	000	000	000
20	050201	000	000	025	000	000	025	050202	000	000	000	050	080	075	050203	000	000	000	055	085	085	050204	000	000	000	060	085	085
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20	110502	000	000	070	000	070	000	110503	050	050	050	050	065	000	120101	050	050	060	050	000	000	120102	000	000	060	000	000	000
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20	130301	000	000	000	000	000	090	130302	000	000	080	000	000	080	140101	050	050	050	050	050	050	140102	000	000	000	050	050	050
20	140103	000	000	060	050	000	050	140104	000	000	050	055	065	000	140105	000	000	070	000	000	000	140201	060	060	060	065	070	000
20	140202	000	000	060	060	060	000	140203	000	000	050	050	050	000	140204	000	000	050	050	050	000	140205	000	000	160	000	000	050
20	140301	000	000	055	055	060	055	140302	000	000	000	000	060	055	140303	000	000	060	060	065	000	140304	000	000	000	050	050	050
20	140305	000	000	050	060	060	000.	140306	000	000	070	000	000	000	150101	060	060	060	060	065	000	150102	060	060	060	060	065	000
20	150201	000	000	060	060	065	060	150202	000	000	060	065	070	060	150203	000	000	060	065	070	060	150204	000	000	060	065	075	060
20	150205	000	000	060	065	070	060	150206	000	000	060	065	070	060	160101	070	075	070	070	095	000	160102	000	000	070	070	080	000
20	160103	000	070	080	070	075	000	160201	000	000	080	080	090	000	160202	000	000	070	070	080	000	160203	000	000	080	080	090	070
20	160204	000	000	070	000	000	000	160205	000	000	060	070	090	000	160206	000	000	070	070	095	070	160207	000	000	060	070	090	060
20	160208	000	000	060	000	000	000	160209	000	000	060	070	080	060	160210	000	000	080	000	000	000	170101	040	040	040	060	065	040
20	170102	000	000	040	045	045	040	170103	000	000	050	050	050	000	170104	030	030	030	000	000	000	170105	000	080	060	060	080	060
20	170106	000	000	090	000	000	000	170107	060	070	060	080	000	000	170108	000	000	000	000	000	060	170201	000	000	030	030	030	000
20	170202	000	000	000	000	000	030	170203	000	000	040	045	045	000	170204	000	000	040	040	040	040	170205	000	000	050	050	050	000
20	170206	000	000	000	000	000	000	170301	000	000	030	030	030	000	170302	000	000	000	000	000	030	170303	000	000	040	045	045	000
20	170304	000	000	040	040	040	040	170305	000	000	050	050	050	000	170306	000	000	000	000	000	060	170401	000	000	030	030	030	000
20	170402	000	000	000	000	000	030	170403	000	000	040	045	045	000	170404	000	000	040	040	040	040	170405	000	000	050	050	050	000
20	170406	000	000	000	000	000	060	170501	000	000	030	030	030	000	170502	000	000	000	000	000	030	170503	000	000	040	045	045	000
20	170504	000	000	040	040	040	040	170505	000	000	050	050	050	000	170506	000	000	000	000	000	060	170601	000	000	030	030	030	000
20	170602	000	000	000	000	000	030	170603	000	000	040	045	045	000	170604	000	000	040	040	040	040	170605	000	000	050	050	050	000
20	170606	000	000	000	000	000	060	170701	040	050	040	060	060	000	170702	000	050	040	060	075	000	170703	000	000	040	060	060	060
20	170704	000	000	060	060	065	000	170705	000	000	000	000	000	065	170801	040	050	040	060	000	000	170802	000	050	040	060	075	000
20	170803	000	000	040	060	060	060	170804	000	000	060	060	065	000	170805	000	000	000	000	000	065	170901	040	045	040	045	060	000
20	170902	000	000	000	000	000	055	170903	000	000	060	060	075	000	170904	000	000	060	000	000	055	170905	000	000	070	070	000	000
20	170906	000	000	000	000	000	070	171001	000	000	070	000	000	060	171002	000	000	070	000	000	060	171003	000	000	000	000	000	050
20	171101	000	200	060	200	200	060	171102	000	000	050	000	000	050														

RATER NO. 21

21	010101	070	055	065	040	000	000	010102	010	010	070	010	000	000	010103	000	000	080	075	070	075	010201	000	000	000	060	065	060
21	010202	000	000	075	070	060	085	010301	000	000	062	050	060	000	010302	000	000	061	000	000	000	010303	000	000	040	000	000	000
21	020101	000	000	000	000	090	075	020102	000	000	060	075	084	090	020103	000	000	075	060	060	065	020104	000	000	035	040	030	070
21	020105	000	000	030	030	052	020	020106	000	000	070	086	073	095	020201	000	000	020	000	000	084	020202	000	000	080	000	067	093
21	020203	000	000	063	000	000	099	020204	000	000	085	000	000	087	020205	000	000	095	043	000	000	020301	000	000	010	070	000	000
21	020302	000	000	096	090	098	082	020303	000	000	078	097	093	000	020304	000	000	068	084	080	000	020305	000	000	040	000	079	000
21	030101	000	000	095	093	097	096	030102	000	000	080	087	000	080	030103	000	000	075	000	090	000	030201	000	000	068	075	000	091
21	030202	000	000	093	092	093	000	030203	000	000	055	060	091	000	030301	000	000	045	000	000	085	030302	000	000	097	080	089	000
21	030303	000	000	087	000	000	000	040101	000	000	093	083	050	093	040102	000	000	097	000	000	000	040201	000	000	080	073	060	084
21	040202	000	000	085	067	089	080	040203	000	000	099	099	099	099	040204	000	000	179	078	068	081	040205	000	000	065	084	083	087
21	040206	000	000	084	092	082	082	040207	000	000	052	060	073	063	040208	000	000	030	020	000	010	040209	000	000	000	085	087	085
21	040210	000	000	000	080	094	091	040211	000	000	098	092	090	090	040212	000	000	070	000	000	000	040213	000	000	063	081	095	092
21	040301	000	000	086	086	094	096	040302	000	000	000	050	069	070	040303	000	000	083	000	000	000	040304	000	000	091	000	000	095
21	040401	087	085	092	081	000	000	040402	000	000	010	000	081	010	040403	000	000	000	040	077	064	040404	000	000	000	030	030	061
21	040405	000	000	050	000	030	075	050101	000	000	000	060	060	070	050102	090	000	087	000	090	080	050103	097	097	096	000	000	000
21	050201	000	000	085	000	000	075	050202	000	000	000	070	085	060	050203	000	000	000	050	070	065	050204	000	000	098	030	045	079
21	050301	000	000	095	000	000	085	050302	000	000	097	000	000	000	050303	099	099	090	010	000	000	060101	099	094	090	000	000	000
21	060102	098	085	095	000	000	000	060103	090	000	097	080	085	090	060104	091	000	091	000	000	000	060105	070	000	060	000	060	040
21	060201	000	090	091	000	086	080	060202	000	000	089	095	070	081	060301	000	091	080	000	000	085	060302	000	000	092	000	000	000
21	060303	000	000	085	000	000	000	060401	060	080	086	075	000	000	060402	093	095	079	079	000	000	060403	000	089	099	040	090	080
21	060404	094	081	084	000	000	060	060405	000	000	087	000	000	040	060406	092	070	070	000	000	075	060407	000	000	050	050	050	070
21	070101	000	000	090	075	080	000	070102	000	000	095	000	000	091	070103	000	000	092	070	085	080	070104	000	000	094	069	000	000
21	070105	000	000	096	040	090	000	070201	000	000	080	050	000	081	070202	000	000	081	000	000	000	070301	000	000	079	051	000	085
21	070302	000	000	075	000	000	070	070303	000	000	070	000	000	071	070401	000	000	071	020	081	082	070402	000	000	069	000	000	000
21	070403	085	099	060	071	000	000	070404	000	000	065	090	085	090	080101	000	000	090	000	070	090	080102	000	000	088	093	083	089
21	080103	000	000	091	085	085	000	080104	000	000	085	087	086	000	080105	000	000	092	090	089	000	080106	000	000	089	086	087	000
21	080107	000	000	093	094	096	000	080108	090	085	087	092	080	000	080109	088	000	083	080	082	088	080201	000	000	082	081	075	087
21	080202	000	000	086	060	091	000	080203	000	000	080	000	000	000	080204	000	000	070	000	000	000	080205	085	078	060	061	085	000
21	090101	000	000	085	000	000	080	090102	000	000	086	000	000	078	090103	000	000	070	000	000	085	090201	000	000	090	050	092	000
21	090301	000	000	087	090	000	000	090302	000	000	000	060	090	000	090401	000	000	079	000	085	086	090402	000	000	091	000	093	000
21	090501	000	000	084	075	082	000	090502	000	000	078	080	080	000	090503	000	000	094	070	095	090	090504	000	000	083	065	096	081
21	090505	000	000	081	000	000	000	090506	000	000	071	040	070	080	090507	000	000	060	000	000	000	110101	000	000	080	075	090	000
21	110102	000	060	088	090	086	070	110201	000	072	090	088	070	000	110202	000	000	087	000	000	088	110203	000	000	070	000	000	000
21	110204	000	000	089	000	000	000	110301	000	000	086	000	000	000	110302	000	000	084	000	000	000	110303	000	000	065	000	000	000
21	110401	000	000	081	085	000	000	110402	000	000	091	086	000	000	110403	000	000	060	070	000	000	110501	000	000	085	081	085	000
21	110502	000	000	079	000	090	000	110503	085	088	061	082	080	000	120101	085	080	085	070	000	000	120102	000	000	086	000	000	000
21	120103	000	000	000	080	065	070	120104	000	000	090	085	080	090	120105	000	000	080	087	085	000	120106	000	000	060	000	000	000
21	120107	000	000	087	000	000	000	120201	000	000	079	086	086	000	120202	000	000	055	050	060	065	120203	000	000	061	090	084	000
21	120204	000	000	070	088	070	085	120205	000	000	081	081	071	000	120206	000	000	071	079	069	000	120207	000	000	072	051	059	000
21	120301	000	090	091	065	095	000	120302	000	000	092	000	000	000	120303	000	000	097	000	000	000	120304	090	085	098	089	096	000
21	130101	000	000	000	000	040	060	130102	000	000	000	000	041	065	130103	000	000	000	000	050	075	130104	095	093	091	080	000	091
21	130105	000	000	080	087	085	090	130201	000	000	000	000	065	080	130202	000	000	000	055	080	095	130203	000	000	000	000	060	000
21	130301	000	000	000	000	000	080	130302	000	000	080	000	000	081	140101	070	080	080	075	085	080	140102	000	000	000	080	075	090
21	140103	000	000	085	083	000	075	140104	000	000	081	085	086	000	140105	000	000	086	000	000	000	140201	085	095	089	090	087	000
21	140202	000	000	082	070	060	000	140203	000	000	075	069	065	000	140204	000	000	070	065	064	000	140205	000	000	000	000	000	085
21	140301	000	000	071	060	055	081	140302	000	000	000	000	054	082	140303	000	000	087	084	088	000	140304	000	000	000	071	059	083
21	140305	000	000	090	089	089	000	140306	000	000	050	000	000	000	150101	075	085	080	070	078	000	150102	080	086	075	075	080	000
21	150201	000	000	085	085	090	080	150202	000	000	086	090	095	090	150203	000	000	084	089	091	091	150204	000	000	090	091	096	085
21	150205	000	000	083	080	085	081	150206	000	000	079	081	070	075	160101	095	095	090	085	085	000	160102	000	000	080	086	080	000
21	160103	000	090	091	090	090	030	160201	000	000	075	084	084	000	160202	000	000	092	091	095	000	160203	000	000	086	080	094	080
21	160204	000	000	089	000	000	000	160205	000	000	088	087	091	000	160206	000	000	085	088	096	090	160207	000	000	084	079	075	075
21	160208	000	000	083	000	000	000	160209	000	000	093	092	092	085	160210	000	000	070	000	000	000	170101	060	085	080	075	080	085
21	170102	000	000	070	085	081	080	170103	000	000	071	080	082	000	170104	075	080	069	000	000	000	170105	000	086	081	070	060	081
21	170106	000	000	085	000	000	000	170107	080	079	086	050	000	000	170108	000	000	000	000	000	075	170201	000	000	065	060	050	000
21	170202	000	000	000	000	000	070	170203	000	000	082	081	050	000	170204	000	000	060	050	010	040	170205	000	000	075	059	069	000
21	170206	000	000	000	000	000	071	170301	000	000	065	060	050	000	170302	000	000	000	000	000	070	170303	000	000	082	081	050	000
21	170304	000	000	060	050	010	040	170305	000	000	075	059	069	000	170306	000	000	000	000	000	071	170401	000	000	065	060	050	000
21	170402	000	000	000	050	000	070	170403	000	000	082	081	050	000	170404	000	000	060	050	010	040	170405	000	000	075	059	069	000
21	170406	000	000	000	000	000	071	170501	000	000	065	060	050	000	170502	000	000	000	000	000	070	170503	000	000	082	081	050	000
21	170504	000	000	060	050	010	040	170505	000	000	075	059	069	000	170506	000	000	000	000	000	071	170601	000	000	065	060	050	000
21	170602	000	000	000	000	000	070	170603	000	000	082	081	050	000	170604	000	000	060	050	010	040	170605	000	000	075	059	069	000
21	170606	000	000	000	000	000	071	170701	089	080	090	075	090	000	170702	000	070	080	085	085	000	170703	000	000	076	080	086	081
21	170704	000	000	070	081	087	000	170705	000	000	000	000	000	082	170801	085	081	081	076	000	000	170802	000	070	080	085	085	000
21	170803	000	000	076	080	086	081	170804	000	000	070	081	087	000	170805	000	000	000	000	000	082	170901	087	082	077	085	084	000
21	170902	000	000	000	000	000	078	170903	000	000	087	080	060	000	170904	000	000	060	000	000	075	170905	000	000	090	081	000	000
21	170906	000	000	000	000	000	087	171001	000	000	080	000	000	086	171002	000	000	081	000	000	085	171003	000	000	000	000	000	089
21	171101	000	074	079	082	075	084	171102	000	000	068	000	000	077														

RATER NO. 22

INCOMPLETE RATINGS-
NOT USED IN DATA ANALYSIS

RATER NO. 23

23	010101	040	060	080	078	000	000	010102	090	060	085	085	000	000	010103	000	000	090	080	050	080	010201	000	000	000	080	070	050
23	010202	000	000	085	070	075	088	010301	000	000	088	080	078	000	010302	000	000	090	000	000	000	010303	000	000	090	000	000	000
23	020101	000	000	000	000	085	070	020102	000	000	080	090	090	070	020103	000	000	093	088	096	095	020104	000	000	080	089	076	068
23	020105	000	000	070	085	089	080	020106	000	000	068	081	083	079	020201	000	000	083	000	000	078	020202	000	000	085	000	081	075
23	020203	000	000	080	000	000	085	020204	000	000	075	000	000	080	020205	000	000	085	080	000	000	020301	000	000	088	080	000	000
23	020302	000	000	080	085	076	087	020303	000	000	070	078	080	000	020304	000	000	080	087	090	000	020305	000	000	080	000	090	000
23	030101	000	000	087	080	082	090	030102	000	000	080	076	000	078	030103	000	000	040	000	053	000	030201	000	000	078	085	000	088
23	030202	000	000	086	082	065	000	030203	000	000	079	087	086	000	030301	000	000	083	000	000	092	030302	000	000	083	088	089	000
23	030303	000	000	089	000	000	000	040101	000	000	088	090	087	093	040102	000	000	080	000	000	087	040201	000	000	083	086	071	090
23	040202	000	000	081	083	087	089	040203	000	000	079	081	083	087	040204	000	000	000	085	077	088	040205	000	000	076	079	083	088
23	040206	000	000	080	083	081	090	040207	000	000	081	079	083	087	040208	000	000	078	080	000	082	040209	000	000	000	070	078	080
23	040210	000	000	000	060	071	086	040211	000	000	050	062	070	082	040212	000	000	072	000	000	000	040213	000	000	083	085	081	089
23	040301	000	000	080	081	088	094	040302	000	000	000	082	088	091	040303	000	000	089	000	000	000	040304	000	000	088	000	000	094
23	040401	094	091	090	094	000	000	040402	000	000	088	000	086	091	040403	000	000	000	088	089	093	040404	000	000	000	083	088	092
23	040405	000	000	086	000	089	094	050101	000	000	000	080	086	089	050102	093	000	088	000	089	092	050103	094	091	097	000	000	000
23	050201	000	000	093	000	000	084	050202	000	000	000	086	089	080	050203	000	000	000	086	088	090	050204	000	000	086	088	092	095
23	050301	000	000	088	000	000	090	050302	000	000	090	000	000	000	050303	097	091	086	094	000	000	060101	097	095	093	000	000	000
23	060102	098	096	093	000	000	000	060103	099	000	095	093	091	098	060104	099	000	095	000	000	000	060105	098	000	091	000	090	096
23	060201	000	094	093	000	096	098	060202	000	000	089	091	093	096	060301	000	089	090	000	000	091	060302	000	000	090	000	000	000
23	060303	000	000	090	000	000	000	060401	098	096	095	093	000	000	060402	099	098	097	093	000	000	060403	000	098	097	098	099	094
23	060404	099	096	091	000	000	095	060405	000	000	091	000	000	093	060406	099	096	096	000	000	098	060407	000	000	093	088	084	093
23	070101	000	000	092	086	089	000	070102	000	000	091	000	000	093	070103	000	000	088	090	091	094	070104	000	000	090	092	000	000
23	070105	000	000	086	088	090	000	070201	000	000	088	090	000	092	070202	000	000	091	000	000	000	070301	000	000	093	095	000	096
23	070302	000	000	089	000	000	094	070303	000	000	093	000	000	095	070401	000	000	088	091	090	094	070402	000	000	090	000	000	000
23	070403	099	097	094	093	000	000	070404	000	000	087	084	088	090	080101	000	000	087	000	090	088	080102	000	000	088	086	090	090
23	080103	000	000	086	088	090	000	080104	000	000	084	086	090	000	080105	000	000	087	089	090	000	080106	000	000	087	089	090	000
23	080107	000	000	083	084	095	000	080108	095	085	088	086	088	000	080109	090	000	083	088	088	092	080201	000	000	079	081	083	081
23	080202	000	000	086	090	092	000	080203	000	000	081	000	000	000	080204	000	000	091	000	000	000	080205	090	088	086	089	090	000
23	090101	000	000	089	000	000	096	090102	000	000	086	000	000	094	090103	000	000	088	000	000	092	090201	000	000	089	088	095	000
23	090301	000	000	087	092	000	000	090302	000	000	000	088	093	000	090401	000	000	090	000	093	096	090402	000	000	091	000	096	000
23	090501	000	000	088	090	092	000	090502	000	000	088	091	093	000	090503	000	000	088	086	094	096	090504	000	000	086	088	090	094
23	090505	000	000	089	000	000	000	090506	000	000	090	092	091	096	090507	000	000	088	000	000	000	110101	000	000	086	087	090	000
23	110102	000	073	084	086	090	088	110201	000	088	090	091	093	000	110202	000	000	086	000	000	090	110203	000	000	088	000	000	000
23	110204	000	000	090	000	000	000	110301	000	000	088	000	000	000	110302	000	000	088	000	000	000	110303	000	000	090	000	000	000
23	110401	000	000	088	090	000	000	110402	000	000	088	090	000	000	110403	000	000	086	088	000	000	110501	000	000	089	088	090	000
23	110502	000	000	088	000	078	000	110503	095	098	087	070	070	000	120101	096	080	091	094	000	000	120102	000	000	093	000	000	000
23	120103	000	000	000	086	084	089	120104	000	000	089	076	084	091	120105	000	000	090	090	083	000	120106	000	000	092	000	000	000
23	120107	000	000	060	000	000	000	120201	000	000	089	090	086	000	120202	000	000	086	090	090	088	120203	000	000	089	088	092	000
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23	120301	000	089	093	091	094	000	120302	000	000	095	000	000	000	120303	000	000	097	000	000	000	120304	098	074	078	088	060	000
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23	170304	000	000	084	080	084	080	170305	000	000	086	088	089	000	170306	000	000	000	000	000	091	170401	000	000	094	090	087	000
23	170402	000	000	000	000	000	093	170403	000	000	088	083	090	000	170404	000	000	084	080	084	080	170405	000	000	088	083	090	000
23	170406	000	000	000	000	000	091	170501	000	000	094	090	087	000	170502	000	000	000	000	000	093	170503	000	000	088	083	090	000
23	170504	000	000	084	080	084	080	170505	000	000	088	083	090	000	170506	000	000	000	000	000	091	170601	000	000	094	090	087	000
23	170602	000	000	000	000	000	093	170603	000	000	088	083	090	000	170604	000	000	084	080	084	080	170605	000	000	088	083	090	000
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23	170704	000	000	083	086	091	000	170705	000	000	000	000	000	094	170801	095	083	080	081	000	000	170802	000	068	070	073	085	000
23	170803	000	000	073	086	090	093	170804	000	000	083	086	091	000	170805	000	000	000	000	000	094	170901	060	072	080	084	086	000
23	170902	000	000	000	000	000	096	170903	000	000	081	083	086	000	170904	000	000	082	000	000	090	170905	000	000	060	073	000	000
23	170906	000	000	000	000	000	097	171001	000	000	082	000	000	093	171002	000	000	088	000	000	095	171003	000	000	000	000	000	098
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RATER NO. 24

24	010101 030 010 060 065 000 000	010102 015 010 030 035 000 000	010103 000 000 050 060 015 030	010201 000 000 000 035 020 035
24	010202 000 000 060 065 050 070	010301 000 000 060 070 075 000	010302 000 000 030 000 000 000	010303 000 000 025 000 000 000
24	020101 000 000 000 000 090 015	020102 000 000 040 080 072 052	020103 000 000 010 070 080 071	020104 000 000 030 020 018 045
24	020105 000 000 005 005 090 075	020106 000 000 080 070 075 080	020201 000 000 010 000 000 015	020202 000 000 050 000 030 020
24	020203 000 000 040 000 000 050	020204 000 000 040 000 000 080	020205 000 000 050 060 000 000	020301 000 000 040 065 000 000
24	020302 000 000 075 070 082 080	020303 000 000 090 085 090 000	020304 000 000 095 095 095 000	020305 000 000 095 000 092 000
24	030101 000 000 095 070 041 095	030102 000 000 095 010 000 090	030103 000 000 040 000 010 000	030201 000 000 045 067 000 070
24	030202 000 000 082 075 010 000	030203 000 000 015 045 075 000	030301 000 000 065 000 000 060	030302 000 000 035 040 040 000
24	030303 000 000 050 000 000 000	040101 000 000 070 015 010 025	040102 000 000 080 000 000 095	040201 000 000 032 012 010 010
24	040202 000 000 015 010 025 015	040203 000 000 010 005 015 015	040204 000 000 000 065 078 065	040205 000 000 015 010 020 020
24	040206 000 000 060 035 045 040	040207 000 000 010 005 010 010	040208 168 000 022 010 000 075	040209 000 000 000 025 010 015
24	040210 000 000 000 015 010 026	040211 000 000 035 020 020 045	040212 000 000 075 000 000 000	040213 000 000 021 015 015 015
24	040301 000 000 071 060 060 065	040302 000 000 000 025 030 025	040303 000 000 025 000 000 000	040304 000 000 060 000 000 065
24	040401 085 035 030 035 000 000	040402 000 000 009 000 001 001	040403 000 000 000 065 070 005	040404 000 000 000 095 090 090
24	040405 000 000 010 000 015 085	050101 000 000 000 060 048 095	050102 072 000 061 000 090 091	050103 097 095 096 000 000 000
24	050201 000 000 095 000 000 095	050202 000 000 000 010 015 015	050203 000 000 000 076 080 088	050204 000 000 090 095 095 098
24	050301 000 000 095 000 000 095	050302 000 000 091 000 000 000	050303 098 095 095 095 000 000	060101 099 095 090 000 000 000
24	060102 095 098 095 000 000 000	060103 050 000 060 070 080 075	060104 046 000 055 000 000 000	060105 005 000 010 000 010 010
24	060201 000 092 085 000 075 015	060202 000 000 062 071 075 060	060301 000 090 080 000 000 035	060302 000 000 072 000 000 000
24	060303 000 000 060 000 000 000	060401 025 051 035 021 000 000	060402 099 099 099 095 000 000	060403 000 095 090 095 095 030
24	060404 025 020 015 000 000 060	060405 000 000 018 000 000 020	060406 021 015 020 000 000 025	060407 000 000 025 013 015 032
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24	070403 038 055 055 035 000 000	070404 000 000 062 070 075 060	080101 000 000 090 000 070 090	080102 000 000 065 075 090 085
24	080103 000 000 075 080 085 000	080104 000 000 075 075 060 000	080105 000 000 080 075 070 000	080106 000 000 070 080 075 000
24	080107 000 000 062 075 085 000	080108 065 070 090 085 065 000	080109 050 000 035 040 040 050	080201 000 000 090 085 085 080
24	080202 000 000 060 055 060 000	080203 000 000 045 000 000 000	080204 000 000 030 000 000 000	080205 065 030 030 040 050 000
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24	090301 000 000 080 035 000 000	090302 000 000 000 081 080 000	090401 000 000 075 000 085 080	090402 000 000 065 000 062 000
24	090501 000 000 065 075 060 000	090502 000 000 078 075 056 000	090503 000 000 075 080 065 075	090504 000 000 060 071 061 078
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24	110102 000 070 065 080 085 075	110201 000 085 070 065 060 000	110202 000 000 065 000 000 070	110203 000 000 035 000 000 000
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24	110401 000 000 015 015 000 000	110402 000 000 010 015 000 000	110403 000 000 015 020 000 000	110501 000 000 065 060 040 000
24	110502 000 000 010 000 015 000	110503 060 080 065 060 050 000	120101 010 015 010 015 000 000	120102 000 000 010 000 000 000
24	120103 000 000 000 025 075 080	120104 000 000 035 050 065 075	120105 000 000 065 060 045 000	120106 000 000 010 000 000 000
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24	120301 000 035 045 030 015 000	120302 000 000 060 000 000 000	120303 000 000 010 000 000 000	120304 025 030 015 020 010 000
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24	130105 000 000 060 055 015 025	130201 000 000 000 000 005 010	130202 000 000 000 030 005 010	130203 000 000 000 000 010 000
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24	140103 000 000 055 060 000 045	140104 000 000 030 075 070 000	140105 000 000 035 000 000 000	140201 035 060 070 065 065 000
24	140202 000 000 075 070 050 000	140203 000 000 060 075 045 000	140204 000 000 035 060 050 000	140205 000 000 000 000 000 075
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24	160103 000 060 070 065 030 000	160201 000 000 065 035 020 000	160202 000 000 060 030 020 000	160203 000 000 070 030 030 060
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24	160208 000 000 010 000 000 000	160209 000 000 025 035 030 015	160210 000 000 025 000 000 000	170101 020 035 025 030 035 010
24	170102 000 000 050 040 030 015	170103 000 000 015 015 010 000	170104 010 010 015 000 000 000	170105 000 025 020 020 020 035
24	170106 000 000 020 000 000 000	170107 055 030 015 030 000 000	170108 000 000 000 000 000 090	170201 000 000 030 045 035 000
24	170202 000 000 000 000 000 085	170203 000 000 045 040 035 000	170204 000 000 010 010 015 035	170205 000 000 060 030 060 000
24	170206 000 000 000 000 000 090	170301 000 000 030 045 035 000	170302 000 000 000 000 000 085	170303 000 000 045 040 035 000
24	170304 000 000 010 010 015 035	170305 000 000 060 030 060 000	170306 000 000 000 000 000 090	170401 000 000 030 045 035 000
24	170402 000 000 000 000 000 085	170403 000 000 045 040 035 000	170404 000 000 010 010 015 035	170405 000 000 060 030 060 000
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24	170504 000 000 010 010 015 035	170505 000 000 060 030 060 000	170506 000 000 000 000 000 090	170601 000 000 030 045 035 000
24	170602 000 000 000 000 000 085	170603 000 000 045 040 035 000	170604 000 000 010 010 015 035	170605 000 000 060 030 060 000
24	170606 000 000 000 000 000 090	170701 030 035 040 035 010 000	170702 000 030 035 030 025 000	170703 000 000 015 020 010 085
24	170704 000 000 050 050 065 000	170705 000 000 000 000 000 085	170801 045 030 020 035 000 000	170802 000 030 035 030 025 000
24	170803 000 000 015 020 010 085	170804 000 000 050 050 065 000	170805 000 000 000 000 000 085	170901 020 035 035 050 025 000
24	170902 000 000 000 000 000 085	170903 000 000 065 070 065 000	170904 000 000 050 000 000 065	170905 000 000 070 065 000 000
24	170906 000 000 000 000 000 090	171001 000 000 090 000 000 090	171002 000 000 085 000 000 095	171003 000 000 000 000 000 095
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RATER NO. 25

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25	030101	000	000	075	010	040	050	030102	000	000	010	011	000	020	030103	000	000	025	000	030	000	030201	000	000	081	060	000	030
25	030202	000	000	085	085	075	000	030203	000	000	083	090	080	000	030301	000	000	090	000	000	060	030302	000	000	091	075	060	000
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25	040206	000	000	070	012	012	035	040207	000	000	030	006	006	014	040208	000	000	025	015	000	012	040209	000	000	000	013	025	005
25	040210	000	000	000	014	026	006	040211	000	000	011	016	030	007	040212	000	000	005	000	000	000	040213	000	000	012	004	040	004
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25	040401	010	005	004	021	000	000	040402	000	000	007	000	013	003	040403	000	000	000	022	020	022	040404	000	000	000	023	021	011
25	040405	000	000	022	000	005	016	050101	150	000	000	030	010	010	050102	030	000	050	000	020	030	050103	035	050	040	110	000	000
25	050201	000	000	020	000	000	015	050202	000	000	130	050	050	060	050203	000	000	000	070	060	040	050204	000	000	070	075	085	035
25	050301	000	000	085	000	000	050	050302	000	000	090	000	000	000	050303	010	020	025	005	000	000	060101	090	080	091	000	000	000
25	060102	092	085	092	000	000	000	060103	010	000	090	080	070	095	060104	020	150	040	000	000	000	060105	011	000	050	000	050	020
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25	070302	000	000	085	000	000	036	070303	000	000	086	000	000	037	070401	000	000	088	020	010	015	070402	000	000	012	000	000	000
25	070403	010	010	013	005	000	000	070404	000	000	045	014	020	011	080101	000	000	010	000	010	020	080102	000	000	020	010	009	025
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25	110102	000	010	028	030	050	020	110201	000	011	050	005	005	000	110202	000	000	051	000	000	018	110203	000	000	052	000	000	115
25	110204	000	000	053	000	000	117	110301	000	000	055	000	000	000	110302	000	000	057	000	000	000	110303	000	000	054	000	000	000
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25	120204	000	000	031	022	025	025	120205	000	000	029	013	027	000	120206	000	000	012	009	015	000	120207	000	000	013	014	012	000
25	120301	000	025	026	008	009	000	120302	000	000	027	000	000	000	120303	000	000	011	000	000	000	120304	005	008	009	002	004	000
25	130101	120	110	000	000	010	010	130102	000	000	000	000	005	200	130103	000	111	120	000	006	005	130104	010	009	005	010	000	004
25	130105	000	000	010	015	007	015	130201	000	000	000	000	015	020	130202	000	000	115	200	004	021	130203	000	000	000	000	007	000
25	130301	000	000	000	000	000	003	130302	000	030	017	000	000	011	140101	025	010	015	005	015	005	140102	000	000	110	004	003	012
25	140103	000	000	012	032	000	020	140104	000	000	025	015	030	000	140105	000	000	014	000	000	000	140201	001	001	030	040	016	000
25	140202	000	000	020	035	020	000	140203	000	000	020	030	040	000	140204	000	000	050	045	010	000	140205	000	000	109	000	000	010
25	140301	000	000	011	006	017	004	140302	000	000	000	000	002	003	140303	000	000	032	003	035	000	140304	000	000	118	002	007	006
25	140305	000	000	040	020	032	000	140306	000	000	045	000	000	000	150101	010	010	030	020	040	000	150102	005	012	010	005	005	000
25	150201	000	000	020	006	050	020	150202	000	000	025	030	045	010	150203	000	000	032	010	055	005	150204	000	000	040	012	060	006
25	150205	000	000	041	015	065	007	150206	000	000	022	004	042	012	160101	010	020	005	005	020	000	160102	000	000	010	004	005	000
25	160103	000	010	012	020	030	000	160201	000	000	008	006	040	000	160202	000	000	020	007	035	000	160203	000	000	013	003	010	010
25	160204	000	000	025	000	000	000	160205	000	000	030	025	045	000	160206	000	000	040	024	050	011	160207	000	000	026	010	012	005
25	160208	000	000	011	000	000	000	160209	000	000	045	015	042	020	160210	000	000	015	000	000	000	170101	010	005	010	004	020	020
25	170102	000	000	005	015	021	012	170103	000	000	015	010	005	000	170104	005	006	011	000	000	000	170105	000	004	020	025	010	015
25	170106	000	000	030	000	000	000	170107	011	015	025	022	000	000	170108	000	000	000	000	000	017	170201	000	000	006	005	030	000
25	170202	000	000	000	000	000	010	170203	000	000	012	006	035	000	170204	000	000	016	007	006	011	170205	000	000	026	030	008	000
25	170206	000	000	000	000	000	017	170301	000	000	006	005	030	000	170302	000	000	000	000	000	010	170303	000	000	012	006	035	000
25	170304	000	000	016	007	006	011	170305	000	000	026	030	008	000	170306	000	000	000	000	000	017	170401	000	000	006	005	030	000
25	170402	000	000	000	000	000	010	170403	000	000	012	006	035	000	170404	000	000	016	007	006	011	170405	000	000	026	030	008	000
25	170406	000	000	000	000	000	017	170501	000	000	006	005	030	000	170502	000	000	000	000	000	010	170503	000	000	012	006	035	000
25	170504	000	000	016	007	006	011	170505	000	000	026	030	008	000	170506	000	000	000	000	000	017	170601	000	000	006	005	030	000
25	170602	000	000	000	000	000	010	170603	000	000	012	006	035	000	170604	000	000	016	007	006	011	170605	000	000	026	008	030	000
25	170606	000	000	000	000	000	017	170701	009	012	017	011	011	000	170702	000	003	004	016	002	000	170703	000	000	027	021	004	004
25	170704	000	000	028	032	003	010	170705	000	005	000	000	000	005	170801	015	013	018	009	009	000	170802	000	003	004	016	002	000
25	170803	000	000	027	021	004	004	170804	000	000	028	032	003	000	170805	000	000	000	000	000	005	170901	022	013	032	025	008	000
25	170902	000	000	000	000	000	014	170903	000	000	011	014	028	000	170904	000	000	007	000	000	012	170905	000	000	012	017	000	000
25	170906	000	000	000	000	000	013	171001	000	000	050	000	000	060	171002	000	000	055	000	000	055	171003	000	000	000	000	000	057
25	171101	000	018	019	002	030	009	171102	000	000	040	000	000	035														

RATER NO. 26

INCOMPLETE RATINGS-
NOT USED IN DATA ANALYSIS

RATER NO. 27

27	010101	081	068	080	075	000	000	010102	071	055	080	075	000	000	010103	000	000	080	075	078	085	010201	000	000	000	081	080	085
27	010202	000	000	085	084	078	083	010301	000	000	070	081	075	000	010302	000	000	065	000	000	000	010303	000	000	068	000	000	000
27	020101	000	000	000	000	083	071	020102	000	000	090	084	080	077	020103	000	000	092	082	091	074	020104	000	000	081	078	075	064
27	020105	000	000	085	090	078	075	020106	000	000	095	092	082	073	020201	000	000	086	000	000	064	020202	000	000	082	000	076	068
27	020203	000	000	087	000	000	060	020204	000	000	089	000	000	071	020205	000	000	093	086	000	000	020301	000	000	078	075	000	000
27	020302	000	000	072	068	076	073	020303	000	000	086	075	078	000	020304	000	000	075	070	077	000	020305	000	000	090	000	088	000
27	030101	000	000	076	078	070	074	030102	000	000	055	058	000	050	030103	000	000	058	000	075	000	030201	000	000	068	077	000	085
27	030202	000	000	071	075	078	000	030203	000	000	073	068	073	000	030301	000	000	080	000	000	078	030302	000	000	083	056	051	000
27	030303	000	000	081	000	000	000	040101	000	000	080	060	072	078	040102	000	000	075	000	000	080	040201	000	000	060	058	061	050
27	040202	000	000	077	064	065	068	040203	000	000	076	062	064	045	040204	000	000	000	073	075	070	040205	000	000	071	075	080	075
27	040206	000	000	080	082	086	071	040207	000	000	058	059	060	045	040208	000	000	064	068	000	058	040209	000	000	000	057	063	035
27	040210	000	000	000	077	083	081	040211	000	000	078	080	080	072	040212	000	000	060	000	000	000	040213	000	000	071	075	070	069
27	040301	000	000	070	072	071	065	040302	000	000	000	078	074	068	040303	000	000	055	000	000	000	040304	000	000	057	000	000	055
27	040401	067	050	056	088	000	000	040402	000	000	040	000	045	038	040403	000	000	000	089	077	065	040404	000	000	000	071	075	068
27	040405	000	000	082	000	079	070	050101	000	000	000	075	075	070	050102	078	000	068	000	072	065	050103	088	081	055	000	000	000
27	050201	000	000	060	000	000	042	050202	000	000	000	086	088	078	050203	000	000	000	090	092	078	050204	000	000	065	085	086	058
27	050301	000	000	075	000	000	078	050302	000	000	070	000	000	000	050303	085	068	055	088	000	000	060101	065	065	075	000	000	000
27	060102	075	070	060	000	000	000	060103	062	000	078	071	075	078	060104	078	000	063	000	000	000	060105	077	000	080	000	085	075
27	060201	000	079	070	000	065	064	060202	000	000	051	065	067	060	060301	000	074	091	000	000	090	060302	000	000	080	000	000	000
27	060303	000	000	071	000	000	000	060401	073	075	077	071	000	000	060402	096	097	083	088	000	000	060403	000	072	079	081	095	088
27	060404	089	085	080	000	000	082	060405	000	000	084	000	000	078	060406	077	079	080	000	000	066	060407	000	000	085	077	088	080
27	070101	000	000	080	071	090	000	070102	000	000	075	000	000	071	070103	000	000	073	072	087	080	070104	000	000	082	075	000	000
27	070105	000	000	081	079	091	000	070201	000	000	081	070	000	075	070202	000	000	068	000	000	000	070301	000	000	085	075	000	074
27	070302	000	000	080	000	000	068	070303	000	000	069	000	000	074	070401	000	000	084	088	090	073	070402	000	000	064	000	000	000
27	070403	072	072	068	081	000	000	070404	000	000	080	078	085	072	080101	000	000	091	000	095	085	080102	000	000	093	088	097	080
27	080103	000	000	095	090	095	000	080104	000	000	090	090	095	000	080105	000	000	092	095	097	000	080106	000	000	090	097	095	000
27	080107	000	000	091	094	096	000	080108	095	087	000	093	097	000	080109	093	000	081	075	070	071	080201	000	000	085	085	090	088
27	080202	000	000	077	080	085	000	080203	000	000	082	000	000	000	080204	000	000	078	000	000	000	080205	078	070	068	082	071	000
27	090101	000	000	088	000	000	085	090102	000	000	085	000	000	080														
27	090103	000	000	086	000	000	081	090201	000	000	076	078	080	000	090301	000	000	077	080	000	000	090302	000	000	000	083	088	000
27	090401	000	000	085	000	086	081	090402	000	000	079	000	085	000	090501	000	000	080	081	090	000	090502	000	000	081	075	088	000
27	090503	000	000	088	089	095	085	090504	000	000	085	088	091	078	090505	000	000	070	000	000	000	090506	000	000	075	078	090	070
27	090507	000	000	077	000	000	000	110101	000	000	065	071	075	000	110102	000	072	078	074	081	080	110201	000	075	075	080	085	000
27	110202	000	000	081	000	000	071	110203	000	000	084	000	000	000	110204	000	000	077	000	000	000	110301	000	000	080	000	000	000
27	110302	000	000	075	000	000	000	110303	000	000	077	000	000	000	110401	000	000	078	080	000	000	110402	000	000	070	076	000	000
27	110403	000	000	070	072	000	000	110501	000	000	075	077	080	000	110502	000	000	075	000	082	000	110503	080	085	075	077	080	000
27	120101	085	080	072	087	000	000	120102	000	000	040	000	000	000	120103	000	000	000	085	071	078	120104	000	000	070	070	065	080
27	120105	000	000	075	078	071	000	120106	000	000	058	000	000	000	120107	000	000	068	000	000	000	120201	000	000	070	075	068	000
27	120202	000	000	075	078	070	074	120203	000	000	070	072	065	000	120204	000	000	084	073	075	068	120205	000	000	080	070	081	000
27	120206	000	000	070	074	078	000	120207	000	000	061	064	058	000	120301	000	085	078	080	088	000	120302	000	000	070	000	000	000
27	120303	000	000	065	000	000	000	120304	077	070	061	068	056	000	130101	000	000	000	000	077	083	130102	000	000	000	000	078	090
27	130103	000	000	000	000	085	088	130104	073	070	065	068	000	071	130105	000	000	068	073	077	071	130201	000	000	000	000	075	078
27	130202	000	000	000	078	074	070	130203	000	000	000	000	078	000	130301	000	000	000	000	000	072	130302	000	000	080	000	000	075
27	140101	080	080	075	078	085	068	140102	000	000	000	083	088	074	140103	000	000	072	081	000	067	140104	000	000	068	070	065	000
27	140105	000	000	065	000	000	000	140201	085	071	067	081	068	000	140202	000	000	060	055	041	000	140203	000	000	063	068	045	000
27	140204	000	000	072	048	038	000	140205	000	000	000	000	000	039	140301	000	000	075	080	075	063	140302	000	000	000	000	048	050
27	140303	000	000	067	075	070	000	140304	000	000	000	078	080	071	140305	000	000	075	073	068	000	140306	000	000	060	000	000	000
27	150101	071	088	081	090	065	000	150102	068	085	075	080	077	000	150201	000	000	078	084	078	075	150202	000	000	085	078	080	090
27	150203	000	000	068	073	090	088	150204	000	000	073	081	088	085	150205	000	000	077	075	085	079	150206	000	000	071	077	083	095
27	160101	095	097	088	091	098	000	160102	000	000	093	090	095	000	160103	000	000	091	092	088	000	160201	000	000	086	094	095	000
27	160202	000	000	089	091	097	000	160203	000	000	085	090	098	082	160204	000	000	083	000	000	000	160205	000	000	088	078	085	000
27	160206	000	000	093	090	096	091	160207	000	000	083	087	091	094	160208	000	000	084	000	000	000	160209	000	000	091	094	098	085
27	160210	000	000	070	000	000	000	170101	061	070	073	075	071	070	170102	000	000	067	070	070	065	170103	000	000	055	058	060	000
27	170104	057	060	051	000	000	000	170105	000	040	059	055	035	068	170106	000	000	063	000	000	000	170107	045	038	068	060	000	000
27	170108	000	000	000	000	000	055	170201	000	000	065	078	070	000	170202	000	000	000	000	000	059	170203	000	000	068	081	080	000
27	170204	000	000	060	080	075	078	170205	000	000	068	078	075	000	170206	000	000	000	000	000	088	170301	000	000	065	078	070	000
27	170302	000	000	000	000	000	059	170303	000	000	068	081	080	000	170304	000	000	060	080	075	078	170305	000	000	068	078	075	000
27	170306	000	000	000	000	000	088	170401	000	000	065	078	070	000	170402	000	000	000	000	000	059	170403	000	000	068	081	080	000
27	170404	000	000	060	080	075	078	170405	000	000	068	078	075	000	170406	000	000	000	000	000	086	170501	000	000	065	078	070	000
27	170502	000	000	000	000	000	059	170503	000	000	068	081	080	000	170504	000	000	060	080	075	078	170505	000	000	068	078	075	000
27	170506	000	000	000	000	000	088	170601	000	000	065	078	070	000	170602	000	000	000	000	000	059	170603	000	000	068	081	080	000
27	170604	000	000	060	080	075	078	170605	000	000	068	078	075	000	170606	000	000	000	000	000	084	170701	090	088	071	065	075	000
27	170702	000	085	081	087	086	000	170703	000	000	070	078	076	071	170704	000	000	066	073	077	000	170705	000	000	000	000	000	087
27	170801	090	085	073	077	000	000	170802	000	085	081	087	086	000	170803	000	000	070	078	076	071	170804	000	000	066	073	077	000
27	170805	000	000	000	000	000	087	170901	070	075	066	078	080	000	170902	000	000	000	000	000	064	170903	000	000	070	073	075	000
27	170904	000	000	060	000	000	070	170905	000	000	045	058	000	000	170906	000	000	000	000	000	068	171001	000	000	066	000	000	069
27	171002	000	000	073	000	000	077	171003	000	000	000	000	000	048	171101	000	077	079	080	070	063	171102	000	000	080	000	000	078

RATER NO. 28

28	010101	030	050	070	070	000	000	010102	030	030	030	030	000	000	010103	000	000	030	030	030	030	010201	000	000	000	030	030	010
28	010202	000	000	010	010	010	050	010301	000	000	010	010	010	000	010302	000	000	070	000	000	000	010303	000	000	010	000	000	000
28	020101	000	000	000	000	010	030	020102	000	000	090	010	010	090	020103	000	000	050	010	010	050	020104	000	000	050	030	030	090
28	020105	000	000	070	030	010	050	020106	000	000	030	030	030	070	020201	000	000	090	000	000	090	020202	000	000	090	000	030	090
28	020203	000	000	090	000	000	090	020204	000	000	090	000	000	090	020205	000	000	090	090	000	000	020301	000	000	090	090	000	000
28	020302	000	000	070	070	070	070	020303	000	000	070	070	070	000	020304	000	000	050	050	010	000	020305	000	000	050	000	030	000
28	030101	000	000	090	090	090	090	030102	000	150	070	050	000	000	030103	000	170	090	000	050	000	030201	000	000	050	030	000	050
28	030202	000	000	070	050	030	000	030203	000	000	090	070	070	000	030301	000	000	090	000	000	090	030302	000	000	090	090	090	000
28	030303	000	000	090	000	000	000	040101	000	000	090	090	090	090	040102	000	000	090	000	000	090	040201	000	000	090	090	090	090
28	040202	000	000	090	070	050	090	040203	000	000	090	090	090	090	040204	000	000	000	090	090	090	040205	000	000	050	050	050	050
28	040206	000	000	090	090	090	090	040207	000	000	050	030	030	050	040208	000	000	070	050	000	090	040209	000	000	000	050	050	070
28	040210	000	000	000	070	050	090	040211	000	090	090	090	090	090	040212	000	000	090	000	000	000	040213	000	000	050	050	050	050
28	040301	000	000	070	050	030	050	040302	000	000	000	050	050	050	040303	000	000	070	000	000	000	040304	000	000	090	000	000	090
28	040401	090	090	090	070	000	000	040402	000	000	090	000	090	090	040403	000	000	000	090	090	090	040404	000	000	000	090	090	090
28	040405	000	000	090	000	090	090	050101	000	000	000	090	090	090	050102	090	000	090	000	090	090	050103	050	050	050	000	000	000
28	050201	000	000	090	000	000	090	050202	000	000	000	030	030	050	050203	000	000	000	050	030	070	050204	000	000	070	050	030	070
28	050301	000	000	090	000	000	090	050302	000	000	090	000	000	000	050303	070	070	070	030	000	000	060101	050	050	050	000	000	000
28	060102	090	090	090	000	000	000	060103	050	000	050	050	050	070	060104	070	000	070	000	000	000	060105	050	000	050	000	050	050
28	060201	000	050	050	000	030	070	060202	000	000	090	090	090	090	060301	000	090	090	000	000	090	060302	000	000	090	000	000	000
28	060303	000	000	090	000	000	000	060401	090	050	070	050	000	000	060402	070	050	050	030	000	000	060403	000	050	030	030	010	050
28	060404	070	050	050	000	000	050	060405	000	000	050	000	000	070	060406	070	070	050	000	000	070	060407	000	000	090	090	090	090
28	070101	000	000	070	070	050	000	070102	000	000	090	000	000	090	070103	000	000	090	090	090	090	070104	000	000	090	090	000	000
28	070105	000	000	070	070	030	000	070201	000	000	090	090	000	090	070202	000	000	090	000	000	000	070301	000	000	090	090	000	090
28	070302	000	000	090	000	000	090	070303	000	000	090	000	000	090	070401	000	000	090	090	090	090	070402	000	000	050	000	000	000
28	070403	050	050	050	030	000	000	070404	000	000	030	030	030	030	080101	000	000	090	000	090	090	080102	000	000	050	050	050	050
28	080103	000	000	090	090	090	000	080104	000	000	090	090	090	000	080105	000	000	090	090	090	000	080106	000	000	090	090	090	000
28	080107	000	000	090	090	090	000	080108	050	050	030	030	050	000	080109	090	000	090	090	090	090	080201	000	000	030	010	010	010
28	080202	000	000	050	010	010	000	080203	000	000	010	000	000	000	080204	000	000	090	000	000	000	080205	050	050	050	030	010	000
28	090101	000	000	090	000	000	090	090102	000	000	090	000	000	090	090103	000	000	090	000	000	090	090201	000	000	090	090	050	000
28	090301	000	000	090	090	000	000	090302	000	000	000	070	030	000	090401	000	000	090	000	030	090	090402	000	000	070	000	010	000
28	090501	000	000	070	070	010	000	090502	000	000	010	010	010	000	090503	000	000	070	070	050	070	090504	000	000	030	030	030	030
28	090505	000	000	090	000	000	000	090506	000	000	090	050	050	050	090507	000	000	090	000	000	000	110101	000	000	050	030	030	000
28	110102	000	010	030	030	030	050	110201	000	050	050	050	050	000	110202	000	000	050	000	000	050	110203	000	000	090	000	000	000
28	110204	000	000	090	000	000	000	110301	000	000	090	000	000	000	110302	000	000	090	000	000	000	110303	000	000	050	000	000	000
28	110401	000	000	050	050	000	000	110402	000	000	070	070	000	000	110403	000	000	070	070	000	000	110501	000	000	050	090	090	000
28	110502	000	000	050	000	050	000	110503	050	050	050	050	030	000	120101	050	050	050	030	000	000	120102	000	000	050	000	000	000
28	120103	000	000	000	010	010	070	120104	000	000	030	030	050	050	120105	000	000	030	030	030	000	120106	000	000	090	000	000	000
28	120107	000	000	030	000	000	000	120201	000	000	050	050	050	000	120202	000	000	090	090	090	090	120203	000	000	050	050	050	000
28	120204	000	000	090	090	090	090	120205	000	000	050	050	050	000	120206	000	000	090	090	090	000	120207	000	000	090	090	090	000
28	120301	000	030	030	030	000	000	120302	000	000	030	000	090	000	120303	000	000	090	000	000	000	120304	090	050	030	030	010	000
28	130101	000	000	000	000	070	090	130102	000	000	000	000	070	090	130103	000	000	000	000	070	090	130104	070	070	050	050	000	050
28	130105	000	000	050	030	010	030	130201	000	000	000	000	010	090	130202	000	000	000	090	090	090	130203	000	000	000	000	090	000
28	130301	000	000	000	000	000	090	130302	000	000	090	000	000	090	140101	010	010	010	010	010	010	140102	000	000	000	010	010	050
28	140103	000	000	050	050	000	090	140104	000	000	010	030	010	000	140105	000	000	070	000	000	000	140201	030	030	050	020	020	000
28	140202	000	000	010	010	030	000	140203	000	000	090	090	090	000	140204	000	000	090	090	090	000	140205	000	000	000	000	000	090
28	140301	000	000	090	090	090	090	140302	000	000	000	000	090	090	140303	000	000	090	090	090	000	140304	000	000	000	090	090	090
28	140305	000	000	090	090	090	000	140306	000	000	090	000	000	000	150101	030	030	030	010	010	000	150102	030	030	030	010	010	000
28	150201	000	000	030	030	030	030	150202	000	000	030	030	030	030	150203	000	000	030	010	010	030	150204	000	000	030	030	010	030
28	150205	000	000	030	030	030	030	150206	000	000	010	010	010	010	160101	030	020	010	010	010	000	160102	000	000	010	010	010	000
28	160103	000	010	010	010	010	000	160201	000	000	010	010	010	000	160202	000	000	010	010	010	000	160203	000	000	010	010	010	050
28	160204	000	000	010	000	000	000	160205	000	000	010	010	010	000	160206	000	000	010	010	010	050	160207	000	000	010	010	010	050
28	160208	000	000	030	000	000	000	160209	000	000	030	030	030	030	160210	000	000	050	000	000	000	170101	050	050	030	030	030	050
28	170102	000	000	030	030	030	070	170103	000	000	050	050	050	000	170104	050	050	050	000	000	000	170105	000	070	070	070	050	070
28	170106	000	000	090	000	000	000	170107	070	070	030	030	000	000	170108	000	000	000	000	000	090	170201	000	000	050	050	050	000
28	170202	000	000	000	000	000	090	170203	000	000	090	090	090	000	170204	000	000	090	090	090	090	170205	000	000	030	030	030	000
28	170206	000	000	050	000	000	090	170301	000	000	050	050	050	000	170302	000	000	000	000	000	090	170303	000	000	090	090	090	000
28	170304	000	000	090	090	090	090	170305	000	000	030	030	030	000	170306	000	000	000	000	000	090	170401	000	000	050	050	050	000
28	170402	000	000	000	000	000	090	170403	000	000	090	090	090	000	170404	000	000	090	090	090	090	170405	000	000	030	030	030	000
28	170406	000	000	000	000	000	090	170501	000	000	050	050	050	000	170502	000	000	000	000	000	090	170503	000	000	090	090	090	000
28	170504	000	000	090	090	090	090	170505	000	000	030	030	030	000	170506	000	000	000	000	000	090	170601	000	000	050	050	050	000
28	170602	000	000	000	000	000	090	170603	000	000	090	090	090	000	170604	000	000	090	090	090	090	170605	000	000	030	030	030	000
28	170606	000	000	000	000	000	090	170701	050	050	050	030	020	000	170702	000	090	070	090	090	000	170703	000	000	050	090	090	090
28	170704	000	000	050	050	050	000	170705	000	000	000	000	000	090	170801	050	050	050	090	000	000	170802	000	090	090	090	090	000
28	170803	000	000	050	090	090	090	170804	000	000	050	050	050	000	170805	000	000	000	000	000	090	170901	030	030	030	030	030	000
28	170902	000	000	000	000	000	090	170903	000	000	070	050	030	000	170904	000	000	090	000	000	090	170905	000	000	050	050	000	000
28	170906	000	000	000	000	000	090	171001	000	000	090	000	000	090	171002	000	000	090	000	000	090	171003	000	000	000	000	000	090
28	171101	000	030	050	050	030	050	171102	000	000	090	000	000	090														

RATER NO. 29

29	010101	050	080	090	090	000	000	010102	052	050	050	050	000	000	010103	000	000	080	070	060	090	010201	000	000	000	020	020	050
29	010202	000	000	095	095	070	095	010301	000	000	055	060	050	000	010302	000	000	097	000	000	000	010303	000	000	056	000	000	000
29	020101	000	000	000	000	096	094	020102	000	000	085	035	092	082	020103	000	000	030	020	030	080	020104	000	000	095	040	095	096
29	020105	000	000	035	025	085	085	020106	000	000	099	045	099	099	020201	000	000	090	000	000	090	020202	000	000	050	000	083	095
29	020203	000	000	040	000	000	049	020204	000	000	029	000	000	092	020205	000	000	093	070	000	000	020301	000	000	096	075	000	000
29	020302	000	000	093	085	050	093	020303	000	000	080	080	080	000	020304	000	000	075	075	089	000	020305	000	000	070	000	090	000
29	030101	000	000	050	050	090	080	030102	000	000	055	055	000	081	030103	000	000	054	000	085	000	030201	000	000	095	095	000	092
29	030202	000	000	094	094	095	190	030203	000	000	096	096	096	191	030301	000	000	052	000	000	093	030302	000	000	053	053	053	000
29	030303	000	000	051	000	000	194	040101	000	000	050	080	040	080	040102	000	000	080	000	000	091	040201	000	000	051	079	041	079
29	040202	000	000	081	088	080	082	040203	000	000	090	095	095	095	040204	000	000	000	090	085	085	040205	000	000	082	089	086	050
29	040206	000	000	083	091	084	086	040207	000	000	084	084	075	075	040208	000	000	091	096	000	096	040209	000	000	000	081	055	070
29	040210	000	000	000	078	050	050	040211	000	000	096	097	099	099	040212	000	000	055	000	000	000	040213	000	000	060	070	052	052
29	040301	000	000	097	098	098	098	040302	000	000	000	075	076	065	040303	000	000	056	000	000	000	040304	000	000	065	000	000	088
29	040401	080	080	049	050	000	000	040402	000	000	079	000	077	078	040403	000	000	000	078	096	068	040404	000	000	000	077	090	069
29	040405	000	000	092	000	092	090	050101	000	000	000	068	070	088	050102	090	000	070	000	080	090	050103	095	090	096	000	000	000
29	050201	000	000	095	000	000	089	050202	000	000	000	070	075	091	050203	000	000	000	090	095	095	050204	000	000	080	088	090	094
29	050301	000	000	075	000	000	093	050302	000	000	078	000	000	000	050303	085	091	090	082	000	000	060101	085	090	092	000	000	000
29	060102	080	085	085	000	000	000	060103	087	000	094	085	090	090	060104	075	000	075	000	000	000	060105	050	000	050	000	050	050
29	060201	000	089	091	000	095	095	060202	000	000	093	086	093	093	060301	000	091	088	000	000	096	060302	000	000	089	000	000	000
29	060303	000	000	090	000	000	000	060401	070	070	070	070	000	000	060402	087	087	087	087	000	000	060403	000	095	095	095	097	097
29	060404	055	073	073	000	000	073	060405	000	000	071	000	000	070	060406	056	071	072	000	000	072	060407	000	000	074	075	075	075
29	070101	000	000	085	085	085	000	070102	000	000	086	000	000	085	070103	000	000	088	090	090	087	070104	000	000	091	095	000	000
29	070105	000	000	095	097	095	000	070201	000	000	089	094	000	090	070202	000	000	090	000	000	000	070301	000	000	092	093	000	092
29	070302	000	000	093	000	000	095	070303	000	000	087	000	000	093	070401	000	000	094	096	091	096	070402	000	000	080	000	000	000
29	070403	085	085	081	081	000	000	070404	000	000	082	082	075	075	080101	000	000	080	000	080	095	080102	000	000	085	085	085	070
29	080103	000	000	088	086	086	000	080104	000	000	090	087	087	000	080105	000	000	093	090	090	000	080106	000	000	095	091	093	000
29	080107	000	000	096	095	095	000	080108	085	085	094	096	096	000	080109	095	000	092	092	094	071	080201	000	000	097	097	097	072
29	080202	000	000	098	098	098	000	080203	000	000	070	000	000	000	080204	000	000	075	000	000	000	080205	097	099	099	099	099	000
29	090101	000	000	089	000	000	094	090102	000	000	088	000	000	093														
29	090103	000	000	090	000	000	095	090201	000	000	085	085	090	000	090301	000	000	092	090	000	000	090302	000	000	000	091	091	000
29	090401	000	000	093	000	093	096	090402	000	000	094	000	094	000	090501	000	000	095	095	095	000	090502	000	000	096	096	096	000
29	090503	000	000	099	099	099	099	090504	000	000	098	098	098	098	090505	000	000	097	000	000	000	090506	000	000	085	085	000	085
29	090507	000	000	080	000	000	000	110101	000	000	085	085	090	000	110102	000	085	087	087	095	200	110201	000	090	080	080	080	000
29	110202	000	000	075	000	000	075	110203	000	000	072	000	000	000	110204	000	000	076	000	000	000	110301	000	000	073	000	000	000
29	110302	000	000	065	000	000	000	110303	000	000	066	000	000	000	110401	000	000	077	075	000	000	110402	000	000	074	070	000	000
29	110403	000	000	070	072	000	000	110501	000	000	090	090	093	000	110502	000	000	050	000	070	000	110503	085	095	095	095	097	000
29	120101	040	075	065	070	000	000	120102	000	000	040	000	000	000	120103	000	000	000	075	060	080	120104	000	000	075	076	075	082
29	120105	000	000	068	065	055	000	120106	000	000	070	000	000	000	120107	000	000	071	000	000	000	120201	000	000	080	080	070	000
29	120202	000	000	081	081	080	085	120203	000	000	082	082	082	000	120204	000	000	085	085	085	090	120205	000	000	086	086	086	000
29	120206	000	000	087	087	087	000	120207	000	000	200	200	200	000	120301	000	090	090	090	090	000	120302	000	000	091	000	000	000
29	120303	000	000	092	000	000	000	120304	050	080	093	095	095	000	130101	000	000	000	000	085	085	130102	000	000	000	000	090	090
29	130103	000	000	000	000	092	092	130104	085	085	080	080	000	080	130105	000	000	085	085	095	096	130201	000	000	000	000	094	086
29	130202	000	000	000	079	093	085	130203	000	000	000	000	091	000	130301	000	000	000	000	000	095	130302	000	000	084	000	000	099
29	140101	090	090	090	090	090	099	140102	000	000	000	050	050	050	140103	000	000	070	060	000	055	140104	000	000	075	070	060	000
29	140105	000	000	076	000	000	000	140201	099	099	099	099	099	000	140202	000	000	091	091	091	000	140203	000	000	093	093	093	000
29	140204	000	000	094	094	094	000	140205	000	000	000	000	000	090	140301	000	000	050	050	070	070	140302	000	000	000	000	071	071
29	140303	000	000	060	060	072	000	140304	000	000	000	062	075	075	140305	000	000	095	095	095	000	140306	000	000	096	000	000	000
29	150101	060	060	060	050	060	000	150102	062	062	062	055	075	000	150201	000	000	070	070	085	090	150202	000	000	075	075	087	091
29	150203	000	000	076	080	080	085	150204	000	000	080	090	090	097	150205	000	000	074	085	086	095	150206	000	000	081	091	091	099
29	160101	090	095	095	095	090	000	160102	000	000	090	085	085	000	160103	000	090	085	080	070	000	160201	000	000	091	090	092	000
29	160202	000	000	091	091	089	000	160203	000	000	086	086	093	090	160204	000	000	087	000	000	000	160205	000	000	092	092	095	000
29	160206	000	000	096	096	075	080	160207	000	000	097	082	076	085	160208	000	000	060	000	000	000	160209	000	000	098	098	096	095
29	160210	000	000	065	000	000	000	170101	090	090	080	075	070	090	170102	000	000	050	050	050	050	170103	000	000	055	055	055	000
29	170104	040	020	025	000	000	000	170105	000	093	090	085	060	091	170106	000	000	093	000	000	000	170107	095	035	083	080	000	000
29	170108	000	000	000	000	000	090	170201	000	000	030	035	001	000	170202	000	000	000	000	000	200	170203	000	000	040	045	002	000
29	170204	000	000	045	046	005	005	170205	000	000	046	050	006	000	170206	000	000	000	000	000	093	170301	000	000	030	035	001	000
29	170302	000	000	000	000	000	200	170303	000	000	040	045	002	000	170304	000	000	045	046	005	005	170305	000	000	046	050	006	000
29	170306	000	000	000	000	000	093	170401	000	000	030	035	001	000	170402	000	000	000	000	000	200	170403	000	000	040	045	002	000
29	170404	000	000	045	046	005	005	170405	000	000	046	050	006	000	170406	000	000	000	000	000	093	170501	000	000	030	035	001	000
29	170502	000	000	000	000	000	200	170503	000	000	040	045	002	000	170504	000	000	045	046	005	005	170505	000	000	046	050	006	000
29	170506	000	000	000	000	000	093	170601	000	000	030	035	001	000	170602	000	000	000	000	000	200	170603	000	000	040	045	002	000
29	170604	000	000	045	046	005	005	170605	000	000	046	050	006	000	170606	000	000	000	000	000	093	170701	075	094	094	082	065	000
29	170702	000	095	095	083	066	000	170703	000	000	096	084	067	095	170704	000	000	070	070	010	000	170705	000	000	000	000	000	095
29	170801	075	094	094	082	000	000	170802	000	095	095	083	066	000	170803	000	000	096	084	067	095	170804	000	000	070	070	010	000
29	170805	000	000	000	000	000	095	170901	035	030	028	010	007	000	170902	000	000	000	000	000	030	170903	000	000	060	060	020	000
29	170904	000	000	061	000	000	200	170905	000	000	065	065	000	000	170906	000	000	000	000	000	035	171001	000	000	096	000	000	085
29	171002	000	000	097	000	000	086	171003	000	000	000	000	000	096	171101	000	096	098	098	080	097	171102	000	000	099	000	000	099

RATER NO. 30

INCOMPLETE RATINGS-
NOT USED IN DATA ANALAYSIS

RATER NO. 31

31	010101	055	035	075	015	000	000	010102	015	045	075	015	000	000	010103	000	000	075	015	015	035	010201	000	000	000	045	055	035
31	010202	000	000	075	045	055	035	010301	000	000	025	005	035	000	010302	000	000	025	000	000	000	010303	000	000	045	000	000	000
31	020101	000	000	000	000	055	025	020102	000	000	055	055	065	035	020103	000	000	055	055	065	035	020104	000	000	035	055	065	035
31	020105	000	000	035	055	065	035	020106	000	000	085	065	085	065	020201	000	000	075	000	000	085	020202	000	000	085	000	085	085
31	020203	000	000	065	000	000	085	020204	000	000	065	000	000	085	020205	000	000	075	045	000	000	020301	000	000	045	025	000	000
31	020302	000	000	065	065	045	055	020303	000	000	085	065	045	000	020304	000	000	085	065	065	000	020305	000	000	055	000	055	000
31	030101	000	000	035	045	035	025	030102	000	000	015	015	000	015	030103	000	000	015	000	015	000	030201	000	000	045	045	000	015
31	030202	000	000	025	025	015	000	030203	000	000	025	025	015	000	030301	000	000	035	000	000	025	030302	000	000	025	015	025	000
31	030303	000	000	005	000	000	000	040101	000	000	045	055	045	045	040102	000	000	075	000	000	025	040201	000	000	035	055	045	055
31	040202	000	000	035	055	045	075	040203	000	000	035	055	045	075	040204	000	000	000	055	045	055	040205	000	000	035	055	045	075
31	040206	000	000	055	055	045	035	040207	000	000	035	055	045	055	040208	000	000	035	035	000	025	040209	000	000	000	045	035	025
31	040210	000	000	000	035	035	025	040211	000	000	035	035	025	025	040212	000	000	015	000	000	000	040213	000	000	055	055	045	045
31	040301	000	000	065	065	065	035	040302	000	000	000	045	045	015	040303	000	000	015	000	000	000	040304	000	000	055	000	000	055
31	040401	045	015	015	015	000	000	040402	000	000	015	000	015	005	040403	000	000	000	045	055	025	040404	000	000	000	045	045	045
31	040405	000	000	045	000	015	015	050101	000	000	000	035	025	035	050102	095	000	085	000	085	075	050103	025	025	035	000	000	000
31	050201	000	000	045	000	000	055	050202	000	000	000	055	055	065	050203	000	000	175	055	045	055	050204	000	000	035	035	025	015
31	050301	000	000	035	000	000	045	050302	000	000	015	000	000	000	050303	015	015	015	025	000	000	060101	065	085	065	000	000	000
31	060102	065	065	045	000	000	000	060103	035	000	065	055	055	045	060104	015	000	015	000	000	000	060105	025	000	035	000	035	035
31	060201	000	035	045	000	025	045	060202	000	000	035	035	025	045	060301	000	035	045	000	175	025	060302	000	000	065	000	175	000
31	060303	000	000	055	000	000	000	060401	035	035	015	025	000	000	060402	075	045	095	095	000	000	060403	000	000	065	095	095	065
31	060404	035	035	035	000	000	065	060405	000	000	035	000	000	045	060406	055	045	045	000	000	045	060407	000	000	045	025	035	045
31	070101	000	000	200	200	200	000	070102	000	000	200	000	000	200	070103	000	000	200	200	200	200	070104	000	000	200	200	000	000
31	070105	000	000	200	200	200	000	070201	000	000	035	065	000	085	070202	000	000	075	000	000	000	070301	000	000	075	055	175	085
31	070302	000	000	075	000	185	085	070303	000	000	075	000	185	085	070401	000	000	065	075	075	085	070402	000	000	035	000	000	000
31	070403	035	035	035	045	000	000	070404	000	000	055	015	025	025	080101	000	000	075	000	075	085	080102	000	000	075	200	075	085
31	080103	000	000	095	075	045	000	080104	000	000	095	095	095	000	080105	000	000	200	200	200	000	080106	000	000	200	200	200	000
31	080107	000	000	200	200	200	000	080108	000	000	200	200	200	000	080109	000	000	200	200	200	200	080201	000	000	200	200	200	200
31	080202	000	000	200	200	200	000	080203	000	000	200	000	000	000	080204	000	000	200	000	000	000	080205	200	200	200	200	200	000
31	090101	000	000	045	000	000	075	090102	000	000	045	000	000	075	090103	000	000	025	000	000	075	090201	000	000	045	025	025	000
31	090301	000	000	045	045	000	000	090302	000	000	145	015	015	145	090401	000	000	055	135	035	065	090402	000	000	065	000	045	000
31	090501	000	000	055	055	055	165	090502	000	000	095	085	095	000	090503	000	000	095	055	035	085	090504	000	000	055	055	055	065
31	090505	000	000	025	000	000	000	090506	000	000	055	015	025	025	090507	000	000	015	000	000	000	110101	000	000	095	055	035	000
31	110102	000	085	065	045	025	055	110201	000	005	085	045	025	165	110202	000	000	200	000	000	200	110203	000	000	055	000	000	000
31	110204	000	000	055	000	000	000	110301	000	000	055	000	000	000	110302	000	000	055	000	000	000	110303	000	000	055	000	000	000
31	110401	000	000	025	005	000	000	110402	000	000	025	005	000	000	110403	000	000	025	005	000	000	110501	000	000	045	045	035	000
31	110502	000	000	015	000	005	000	110503	045	045	025	045	025	000	120101	055	025	035	055	000	000	120102	000	000	025	000	000	000
31	120103	000	000	000	045	045	075	120104	000	000	025	035	055	075	120105	000	000	065	065	075	175	120106	000	000	015	000	000	000
31	120107	000	000	035	000	000	000	120201	000	000	065	075	065	000	120202	000	000	075	045	075	075	120203	000	000	015	025	035	000
31	120204	000	000	200	200	200	200	120205	000	000	200	200	200	000	120206	000	000	045	035	045	000	120207	000	000	200	200	200	000
31	120301	000	015	055	035	035	165	120302	000	000	025	000	000	000	120303	000	000	025	000	000	000	120304	015	015	025	025	025	000
31	130101	000	115	155	135	035	065	130102	000	000	000	000	035	035	130103	000	115	155	135	035	065	130104	025	025	025	025	000	035
31	130105	000	000	035	025	025	035	130201	000	000	000	000	000	035	130202	000	000	000	035	035	075	130203	000	000	000	000	035	000
31	130301	000	000	125	000	000	005	130302	000	000	200	000	000	200	140101	200	200	200	200	200	200	140102	000	000	000	200	200	200
31	140103	000	000	200	200	200	200	140104	000	000	200	200	200	000	140105	000	000	200	000	000	000	140201	200	200	200	200	200	000
31	140202	000	000	200	200	200	000	140203	000	000	200	200	200	000	140204	000	000	200	200	200	000	140205	000	000	000	000	000	200
31	140301	000	000	200	200	200	200	140302	000	000	000	000	200	200	140303	000	000	200	200	200	000	140304	000	000	000	200	200	200
31	140305	000	000	200	200	200	000	140306	000	000	200	000	000	000	150101	005	005	005	005	005	000	150102	005	005	005	005	005	000
31	150201	000	000	005	005	005	005	150202	000	000	005	005	005	005	150203	000	000	005	005	005	005	150204	000	000	005	005	005	005
31	150205	000	000	005	005	005	005	150206	000	000	005	005	005	005	160101	095	095	055	075	085	000	160102	000	000	085	085	085	155
31	160103	000	015	065	035	055	000	160201	000	000	055	035	035	155	160202	000	000	055	035	035	155	160203	000	000	035	025	025	055
31	160204	000	000	025	000	000	000	160205	000	000	055	035	035	155	160206	000	000	065	045	045	075	160207	000	000	055	045	045	055
31	160208	000	000	025	000	000	000	160209	000	000	075	075	075	075	160210	000	000	025	000	000	000	170101	200	200	200	200	200	200
31	170102	000	000	200	200	200	200	170103	000	000	200	200	200	000	170104	200	200	200	000	000	000	170105	000	200	200	200	200	200
31	170106	000	000	200	000	000	000	170107	200	200	200	200	000	000	170108	000	000	000	000	000	200	170201	000	000	200	200	200	000
31	170202	000	000	000	000	000	200	170203	000	000	200	200	200	000	170204	000	000	200	200	200	200	170205	000	000	200	200	200	000
31	170206	000	000	000	000	000	200	170301	000	000	200	200	200	000	170302	000	000	000	000	000	200	170303	000	000	200	200	200	000
31	170304	000	000	200	200	200	200	170305	000	000	200	200	200	000	170306	000	000	000	000	000	200	170401	000	000	200	200	200	000
31	170402	000	000	000	000	000	200	170403	000	000	200	200	200	000	170404	000	000	200	200	200	200	170405	000	000	200	200	200	000
31	170406	000	000	000	000	000	200	170501	000	000	200	200	200	000	170502	000	000	000	000	000	200	170503	000	000	200	200	200	000
31	170504	000	000	200	200	200	200	170505	000	000	200	200	200	000	170506	000	000	000	000	000	200	170601	000	000	200	200	200	000
31	170602	000	000	000	000	000	200	170603	000	000	200	200	200	000	170604	000	000	200	200	200	200	170605	000	000	200	200	200	000
31	170606	000	000	000	000	000	200	170701	200	200	200	200	200	000	170702	000	200	200	200	200	000	170703	000	000	200	200	200	200
31	170704	000	000	200	200	200	000	170705	000	000	000	000	000	200	170801	200	200	200	200	000	000	170802	000	200	200	200	200	000
31	170803	000	000	200	200	200	200	170804	000	000	200	200	200	000	170805	000	000	000	000	000	200	170901	200	200	200	200	200	000
31	170902	000	000	000	000	000	200	170903	000	000	200	200	200	000	170904	000	000	200	000	000	200	170905	000	000	200	200	000	000
31	170906	000	000	000	000	000	200	171001	000	000	200	000	000	200	171002	000	000	200	000	000	200	171003	000	000	000	000	000	200
31	171101	000	200	200	200	200	200	171102	000	000	200	000	000	200														

RATER NO. 32

INCOMPLETE RATINGS-
NOT USED IN DATA ANALYSIS

APPENDIX D
DISTRIBUTION OF RATER SCORES

Table D-1 on the following page shows the distribution of the raw scores of individual raters. The scores, which ranged from 1 to 99, have been grouped in five-point intervals for convenience of presentation.

The combined distribution of raw scores for all raters is shown in Figure D-1. For comparison, the distribution of converted scores is plotted in Figure D-2.

Figure D-3 represents a different mode of aggregation. For this presentation, the scores are averaged within each task and the geometric mean score provides the abscissa and frequency of tasks provides the ordinate.

The outcome of concern is that both conversion (normalization) and the use of the geometric mean of the raw scores have an effect of regularizing the distribution (smoothing, adding symmetry, and eliminating skewness), all of which tend to bring the score distributions into better conformity to basic statistical models.

TABLE D-1 DISTRIBUTION OF RAW SCORES BY RATER

RAW SCORE INTERVALS

RATER	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-99
1	28	23	42	1	76	2	77	3	64	1	45	53	1	76	5	71	19	88	64	33
2	6	55	29	11	58	4	51	11	20	6	11	38	25	98	71	162	96	14	2	0
3	20	28	117	19	29	24	33	32	26	18	51	23	16	29	45	34	20	140	10	16
4	1	15	34	10	25	14	28	11	30	15	23	27	29	24	41	53	54	78	127	71
5	16	11	25	51	42	23	57	26	21	30	17	22	37	10	28	38	21	38	75	60
6	0	5	3	0	13	0	46	0	5	0	16	9	0	120	4	116	0	418	12	0
7	0	0	6	0	21	1	13	2	19	7	46	26	26	48	120	95	142	158	38	4
8	30	26	18	11	19	13	26	23	29	10	40	31	38	38	93	81	93	99	38	16
9	3	0	18	0	41	2	52	4	56	4	51	83	32	54	63	77	87	91	39	7
10	31	25	17	2	52	5	42	6	30	3	65	75	10	67	48	99	56	75	39	23
11	0	0	11	11	16	33	35	37	28	45	85	64	47	74	66	87	53	62	17	1
12	4	27	117	112	88	53	73	30	46	27	60	36	10	29	8	22	10	17	1	2
13	0	0	0	0	0	0	0	0	1	6	29	17	39	92	211	193	142	32	8	1
14	0	0	0	0	0	0	0	0	2	6	29	31	67	51	215	175	91	74	22	9
15	0	1	214	0	227	0	70	0	188	0	16	30	0	1	0	17	0	1	0	0
16	0	11	35	6	142	3	196	0	124	1	76	78	0	43	4	41	1	8	0	0
17	1	0	7	0	26	0	43	1	40	3	29	63	8	157	30	147	22	105	27	65
18	0	12	51	23	38	14	42	3	79	15	125	124	21	49	30	57	10	48	23	4
19	0	0	13	0	4	0	8	1	18	2	39	51	31	67	60	89	147	130	77	34
20	0	0	5	5	26	16	22	25	17	15	52	36	57	89	114	111	91	54	36	1
21	0	0	0	0	0	0	1	0	5	1	8	15	5	23	17	94	105	306	147	45
22	2	10	66	51	31	25	54	58	24	27	47	66	60	39	54	41	36	39	33	9
23	40	118	157	61	76	49	60	26	42	16	40	19	6	8	11	10	12	13	6	1
24	0	0	0	0	0	0	0	6	5	9	17	42	46	103	145	164	100	79	41	13
25	0	0	86	0	4	0	136	0	0	0	176	0	0	70	0	0	0	298	0	0
26	10	16	3	0	5	4	9	10	12	23	58	19	13	43	52	56	86	108	150	84
27	0	43	0	44	0	65	0	84	0	72	69	0	40	0	40	0	28	0	16	0

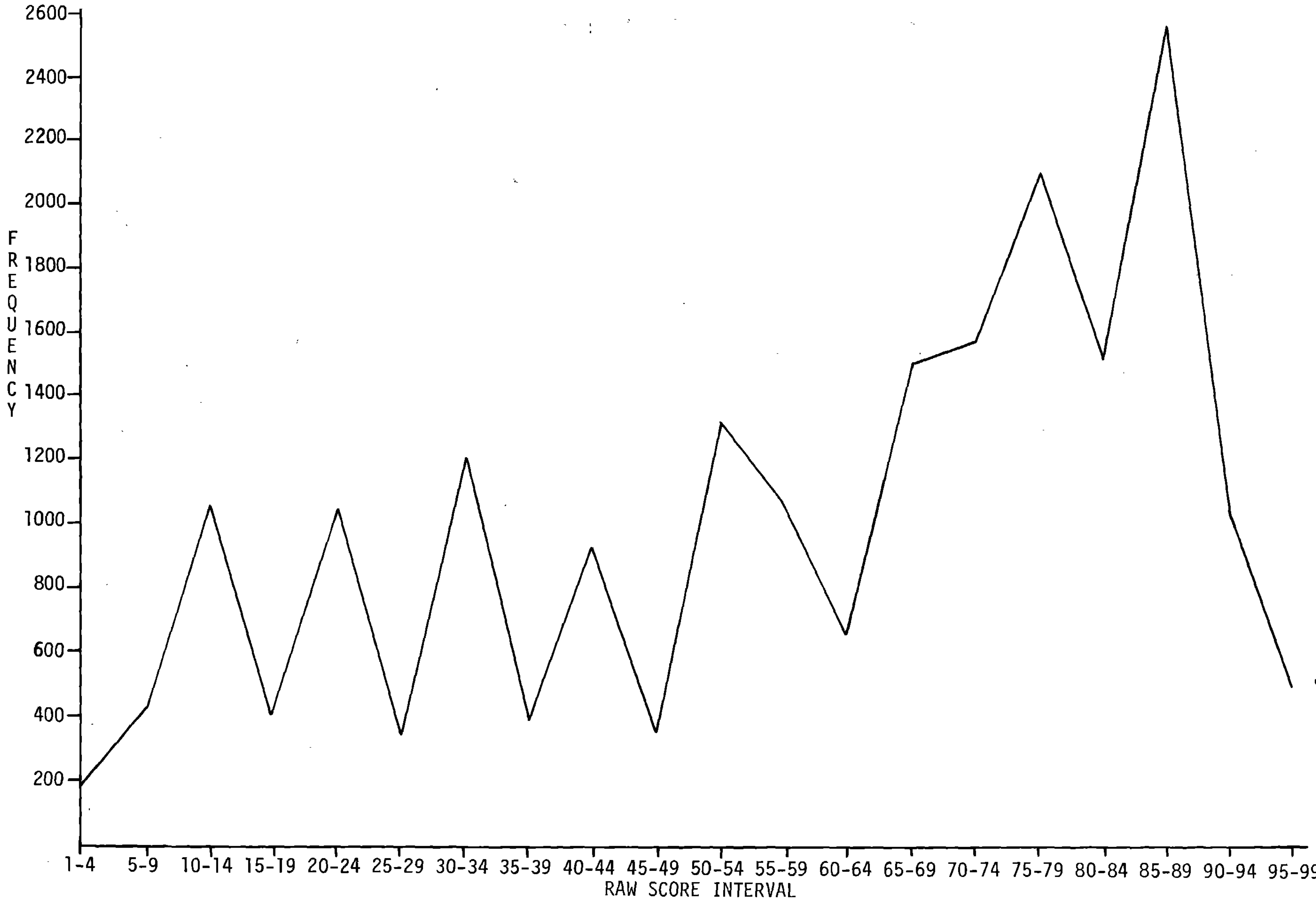

FIGURE D-1 COMBINED FREQUENCY DISTRIBUTION OF RAW SCORES

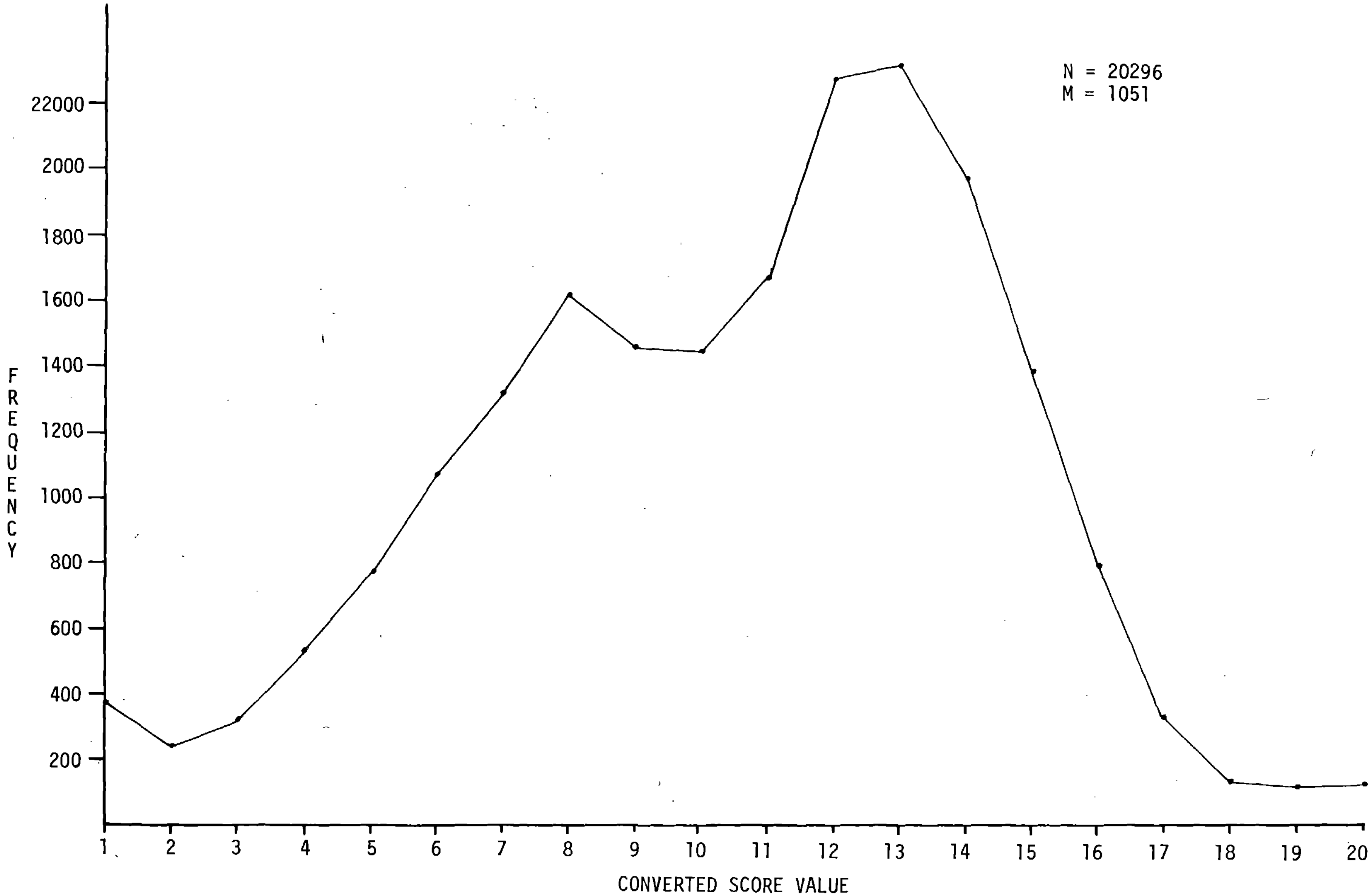

FIGURE D-2 COMBINED FREQUENCY DISTRIBUTION OF CONVERTED SCORES

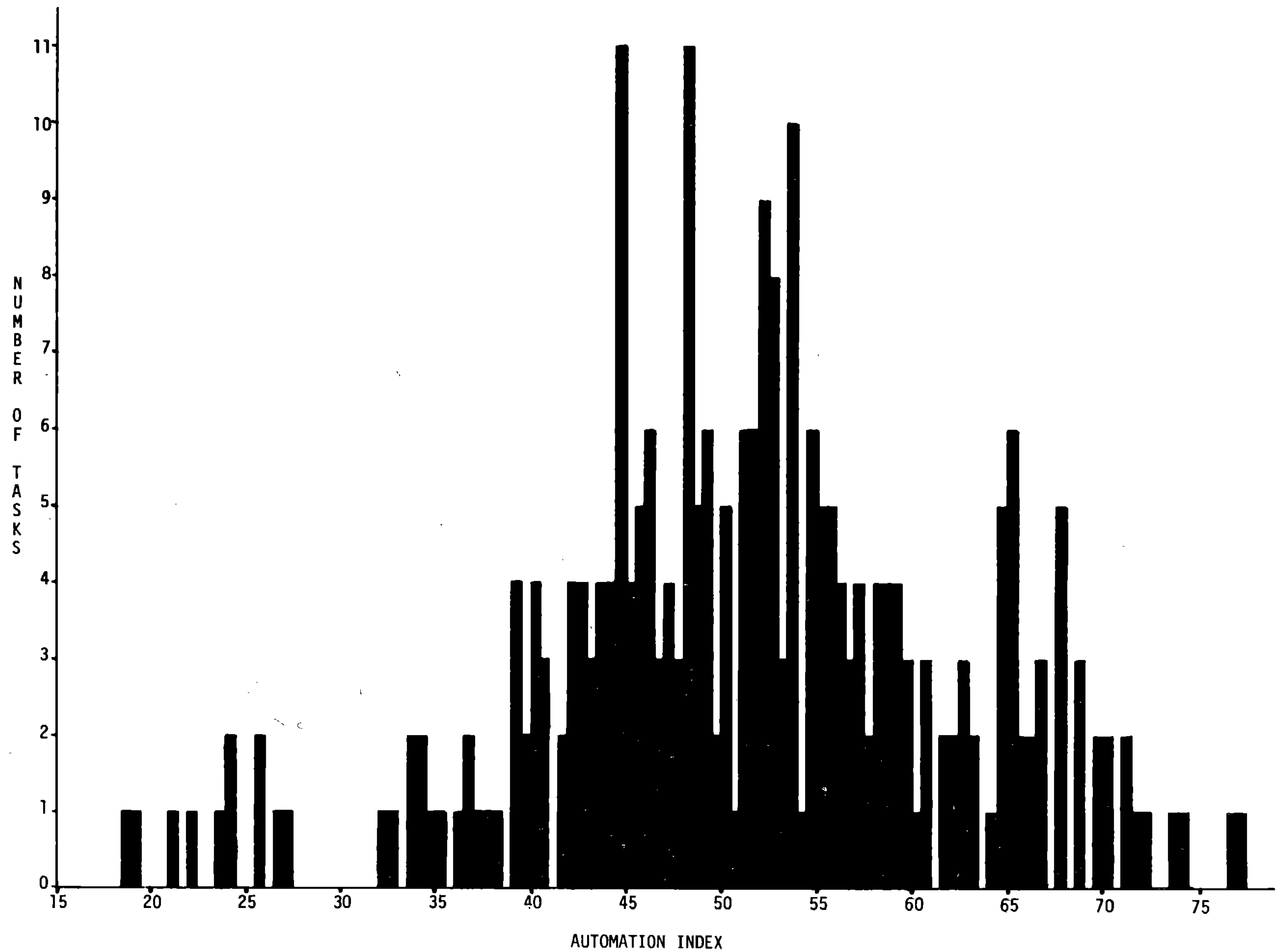

FIGURE D-3 FREQUENCY DISTRIBUTION OF TASKS BY AUTOMATION INDEX (GEOMETRIC MEAN SCORE)

APPENDIX E
AUTOMATION INDICES AND TASK RANKINGS

Table E-1 is a serial listing of tasks with the values and rank order obtained by calculation of the automation index on the basis of geometric mean of raw scores, arithmetic mean of raw scores and arithmetic mean of converted Z-scores.

Table E-2 shows the tasks by rank order of the automation index based on the geometric mean. The corresponding ranks obtained from calculation of the automation index by mean raw score and mean converted Z-score are listed beside each for comparison.

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
1.1.1	52.1	83	59.5	95	10.3	35
1.1.2	40.7	145	50.8	148	9.1	47
1.1.3	42.0	142	52.3	139	9.1	47
1.2.1	44.2	131	53.8	133	9.5	43
1.2.2	54.9	67	62.7	69	11.0	28
1.3.1	42.6	139	52.7	138	9.4	44
1.3.2	52.1	83	60.4	89	10.3	35
1.3.3	36.7	156	51.3	144	9.0	48
2.1.1	45.6	122	58.0	105	9.6	42
2.1.2	47.8	111	58.0	105	9.8	40
2.1.3	45.1	125	55.8	121	9.6	42
2.1.4	44.6	128	53.9	132	9.0	48
2.1.5	40.8	144	51.5	143	8.6	52
2.1.6	53.6	75	63.9	63	11.1	27
2.2.1	58.5	47	67.1	40	11.1	27
2.2.2	56.2	59	65.0	55	10.9	29
2.2.3	58.4	48	66.6	44	11.2	26
2.2.4	59.7	42	65.5	51	11.7	21
2.3.1	53.6	75	62.5	71	11.3	25
2.3.2	49.9	97	59.4	96	10.3	35
2.3.3	60.2	39	66.5	45	11.5	23
2.3.4	61.9	34	68.3	38	12.1	17
2.3.5	66.5	20	70.5	31	12.0	18
3.1.1	37.3	155	53.1	136	9.5	43
3.1.2	25.5	169	40.6	160	6.8	64
3.1.3	25.7	168	39.3	164	6.5	66
3.2.1	46.2	119	58.7	100	10.6	32
3.2.2	46.5	117	60.9	85	11.1	27
3.2.3	49.4	99	61.1	83	10.9	29
3.3.1	44.7	127	55.6	123	9.7	41
3.3.2	39.8	149	50.9	147	9.0	48
3.3.3	19.4	175	36.7	166	6.3	67

See notes at the end of table, page E-10.

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
4.1.1	40.4	146	54.4	130	9.6	42
4.1.2	52.3	81	63.9	63	11.0	28
4.2.1	39.1	152	51.6	142	8.8	50
4.2.2	45.2	124	56.6	117	9.8	40
4.2.3	48.8	104	59.7	93	10.2	36
4.2.4	47.1	114	56.1	119	9.6	42
4.2.5	40.3	147	51.6	142	8.8	50
4.2.6	44.7	127	56.8	115	9.8	40
4.2.7	32.1	165	44.7	155	7.3	60
4.2.8	37.9	154	51.0	146	9.0	48
4.2.9	40.3	147	51.0	146	8.6	52
4.2.10	43.9	132	55.5	124	9.5	43
4.2.11	50.4	94	61.3	81	10.8	30
4.2.12	24.2	171	39.8	162	6.6	65
4.2.13	34.5	159	47.9	151	8.3	55
4.3.1	52.7	78	61.0	84	10.6	32
4.3.2	40.2	148	51.8	141	8.9	49
4.3.3	22.3	173	39.9	161	7.1	62
4.3.4	45.7	121	55.4	125	9.5	43
4.4.1	27.3	166	42.5	158	7.5	58
4.4.2	18.5	176	37.9	165	6.2	68
4.4.3	48.0	109	58.1	104	10.0	38
4.4.4	43.8	133	54.4	130	9.2	46
5.1.1	44.7	127	56.0	120	9.7	41
5.1.2	54.5	70	65.1	54	11.3	25
5.1.3	39.6	150	53.9	132	9.6	42
5.2.1	56.2	59	64.2	62	10.6	32
5.2.2	51.4	88	60.5	88	11.0	28
5.2.3	59.2	45	66.0	47	12.0	18
5.2.4	55.6	61	64.4	60	11.4	24
5.3.1	55.5	62	65.4	52	11.6	22

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
5.3.2	24.4	170	45.4	154	8.1	56
5.3.3	36.0	157	51.2	145	9.3	45
6.1.1	68.6	13	75.9	9	13.0	8
6.1.2	71.0	8	77.9	4	13.3	5
6.1.3	53.7	74	64.9	56	11.5	23
6.1.4	34.0	161	52.0	140	9.2	46
6.1.5	44.3	130	54.5	129	9.2	46
6.2.1	50.4	94	61.0	84	10.6	32
6.2.2	56.3	58	64.4	60	11.1	27
6.3.1	55.5	62	67.9	39	11.9	19
6.3.2	77.3	1	79.8	1	13.8	1
6.3.3	76.5	2	78.3	3	13.5	3
6.4.1	58.5	47	65.5	51	11.5	23
6.4.2	62.8	31	72.7	19	13.2	6
6.4.3	58.5	47	69.1	37	12.6	12
6.4.4	50.4	94	61.2	82	10.7	31
6.4.5	43.4	135	55.1	127	9.7	41
6.4.6	49.1	101	60.1	91	10.4	34
6.4.7	50.0	96	60.9	85	10.7	31
7.1.1	46.3	118	58.6	101	10.4	34
7.1.2	70.1	9	74.6	11	12.8	10
7.1.3	53.9	72	64.4	60	11.2	26
7.1.4	62.8	31	73.9	15	13.1	7
7.1.5	61.5	35	70.4	32	12.5	13
7.2.1	52.3	81	62.2	74	11.1	27
7.2.2	73.5	4	76.2	8	13.4	4
7.3.1	59.8	41	67.9	39	12.1	17
7.3.2	68.6	13	73.4	16	12.5	13
7.3.3	66.9	18	71.8	26	12.2	16
7.4.1	60.8	37	69.3	36	12.2	16
7.4.2	23.5	172	40.6	160	7.4	59
7.4.3	42.0	142	55.1	127	9.9	39

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
7.4.4	53.3	76	63.5	65	11.2	26
8.1.1	57.3	53	64.5	59	11.4	24
8.1.2	65.2	25	72.5	21	12.9	9
8.1.3	66.2	21	71.7	27	12.8	10
8.1.4	65.6	24	72.8	18	13.0	8
8.1.5	71.4	7	77.0	6	13.7	2
8.1.6	72.4	5	77.1	5	13.7	2
8.1.7	68.8	12	74.5	12	13.3	5
8.1.8	62.1	33	70.8	30	12.5	13
8.1.9	52.4	80	62.6	70	10.9	29
8.2.1	58.0	50	66.8	42	11.9	19
8.2.2	67.6	16	72.8	18	13.1	7
8.2.3	54.8	68	62.3	73	10.6	32
8.2.4	42.6	139	51.3	144	9.0	48
8.2.5	49.1	101	59.8	92	10.6	32
9.1.1	54.9	67	66.4	46	11.6	22
9.1.2	53.7	74	64.6	58	11.2	26
9.1.3	63.3	29	69.7	33	12.0	18
9.2.1	← NOT RATED →					
9.2.2	51.3	89	62.1	75	11.2	26
9.3.1	54.9	67	63.9	63	11.8	20
9.3.2	47.3	113	58.8	99	10.7	31
9.4.1	62.1	33	69.4	35	12.2	16
9.4.2	62.6	32	69.7	33	12.3	15
9.5.1	51.2	90	61.4	80	11.2	26
9.5.2	53.8	73	65.0	55	11.8	20
9.5.3	57.2	54	66.9	41	12.2	16
9.5.4	57.2	54	65.4	52	11.9	19
9.5.5	26.8	167	46.6	152	8.5	53
9.5.6	42.8	138	54.6	128	9.7	41
9.5.7	21.4	174	39.4	163	6.9	63

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
11.1.1	58.4	48	66.0	47	11.8	20
11.1.2	54.7	69	63.8	64	11.4	24
11.2.1	52.4	80	63.8	64	11.4	24
11.2.2	55.6	61	63.9	63	11.0	28
11.2.3	67.9	14	72.6	20	12.5	13
11.2.4	64.0	28	71.6	28	12.4	14
11.3.1	69.9	11	74.4	13	13.0	8
11.3.2	69.9	11	74.4	13	12.8	10
11.3.3	65.8	23	71.9	25	12.4	14
11.4.1	56.7	56	65.5	51	12.0	18
11.4.2	56.6	57	65.7	49	11.9	19
11.4.3	56.6	57	64.7	57	11.5	23
11.5.1	54.0	71	61.1	83	10.9	29
11.5.2	41.9	143	53.0	137	9.1	47
11.5.3	55.6	61	63.8	64	11.2	26
12.1.1	45.7	121	56.0	120	10.0	38
12.1.2	34.4	160	44.1	156	7.8	57
12.1.3	48.7	105	57.4	111	10.0	38
12.1.4	57.1	55	62.8	68	11.0	28
12.1.5	42.8	138	54.0	131	9.7	41
12.1.6	35.0	158	45.9	153	7.8	57
12.1.7	33.9	162	42.3	159	7.3	60
12.2.1	58.1	49	63.1	66	11.0	28
12.2.2	52.0	84	59.8	92	10.3	35
12.2.3	51.0	92	57.6	109	10.1	37
12.2.4	53.1	77	60.7	87	10.4	34
12.2.5	51.7	86	58.4	103	10.2	36
12.2.6	51.1	91	59.2	97	10.4	34
12.2.7	46.1	120	54.6	128	9.3	45
12.3.1	51.5	87	59.6	94	10.7	31
12.3.2	59.9	40	65.8	48	11.6	22
12.3.3	32.7	164	45.9	153	8.3	55

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
12.3.4	39.2	151	51.8	141	9.2	46
13.1.1	45.7	121	57.9	106	9.9	39
13.1.2	53.7	74	62.3	73	10.6	32
13.1.3	49.6	98	61.4	80	10.8	30
13.1.4	44.5	129	56.1	119	10.1	37
13.1.5	55.2	64	64.7	57	11.5	23
13.2.1	45.2	124	57.4	111	9.8	40
13.2.2	43.1	137	56.2	118	9.8	40
13.2.3	49.3	100	60.8	86	10.2	36
13.3.1	36.7	156	51.0	146	8.4	54
13.3.2	51.2	90	60.5	88	10.6	32
14.1.1	46.8	116	57.6	109	10.0	38
14.1.2	49.0	102	58.9	98	10.0	38
14.1.3	50.8	93	58.8	99	10.1	37
14.1.4	48.9	103	57.5	110	9.9	39
14.1.5	49.3	100	57.7	108	10.0	38
14.2.1	53.6	75	64.3	61	11.0	28
14.2.2	55.4	63	62.4	72	10.4	34
14.2.3	58.9	46	64.9	56	10.8	30
14.2.4	59.4	43	65.5	51	10.9	29
14.2.5	66.8	19	73.3	17	12.2	16
14.3.1	52.5	79	61.7	78	10.2	36
14.3.2	48.5	107	62.4	72	10.1	37
14.3.3	45.5	123	57.8	107	9.8	40
14.3.4	53.1	77	62.3	73	10.5	33
14.3.5	60.9	36	66.9	41	11.3	25
14.3.6	59.3	44	63.5	65	10.6	32
15.1.1	39.2	151	48.9	150	8.7	51
15.1.2	42.4	140	53.0	137	9.3	45
15.2.1	44.3	130	55.1	127	9.8	40
15.2.2	44.6	128	55.7	122	9.9	39
15.2.3	40.7	145	52.7	138	9.4	44

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
15.2.4	45.0	126	57.3	112	10.3	35
15.2.5	42.3	141	53.5	134	9.5	43
15.2.6	39.1	152	51.6	142	9.1	47
16.1.1	50.2	95	62.5	71	11.4	24
16.1.2	47.6	112	60.5	88	11.0	28
16.1.3	46.8	116	58.1	104	10.7	31
16.2.1	48.6	106	60.3	90	11.0	28
16.2.2	46.1	120	58.0	105	10.9	29
16.2.3	56.1	60	65.6	50	11.7	21
16.2.4	46.1	120	55.3	126	10.1	37
16.2.5	52.7	78	62.7	69	11.4	24
16.2.6	60.6	38	69.6	34	12.8	10
16.2.7	52.2	82	61.8	77	11.2	26
16.2.8	38.4	153	49.2	149	9.0	48
16.2.9	51.5	87	60.4	89	11.0	28
16.2.10	41.9	143	49.3	148	8.9	49
17.1.1	47.0	115	56.9	114	9.6	42
17.1.2	43.3	136	51.3	144	8.6	52
17.1.3	44.3	130	52.7	138	8.7	51
17.1.4	33.5	163	42.9	157	7.2	61
17.1.5	47.9	110	57.0	113	9.6	42
17.1.6	47.3	113	55.4	125	9.3	45
17.1.7	43.5	134	54.0	131	9.2	46
17.1.8	71.9	6	76.6	7	12.9	9
17.2.1	48.4	108	58.5	102	9.8	40
17.2.2	64.7	27	71.2	29	12.0	18
17.2.3	52.7	78	61.9	76	10.5	33
17.2.4	44.5	129	56.8	115	9.5	43
17.2.5	48.4	105	56.8	115	9.6	42
17.2.6	65.0	26	72.3	22	12.1	17
17.3.1	48.4	108	58.5	102	9.8	40
17.3.2	64.7	27	71.2	29	12.0	18

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
17.3.3	52.7	78	61.9	76	10.5	33
17.3.4	44.5	129	56.8	115	9.5	43
17.3.5	48.4	108	56.8	115	9.6	42
17.3.6	65.0	26	72.3	22	12.1	17
17.4.1	48.4	108	58.5	102	9.8	40
17.4.2	64.7	27	71.2	29	12.0	18
17.4.3	52.7	78	61.9	76	10.5	33
17.4.4	44.5	129	56.8	115	9.5	43
17.4.5	48.4	108	56.7	116	9.6	42
17.4.6	65.0	26	72.3	22	12.1	17
17.5.1	48.4	108	58.5	102	9.8	40
17.5.2	64.7	27	71.2	29	12.0	18
17.5.3	52.7	78	61.9	76	10.5	33
17.5.4	44.5	129	56.8	115	9.5	43
17.5.5	48.4	108	56.7	116	9.6	42
17.5.6	65.0	26	72.3	22	12.1	17
17.6.1	48.4	108	58.5	102	9.8	40
17.6.2	64.7	27	71.2	29	12.0	18
17.6.3	52.7	78	61.9	76	10.5	33
17.6.4	44.5	129	56.8	115	9.5	43
17.6.5	48.4	108	56.7	116	9.6	42
17.6.6	65.0	26	72.3	22	12.1	17
17.7.1	55.4	63	63.9	63	11.0	28
17.7.2	51.8	85	62.3	73	10.8	30
17.7.3	53.6	75	63.0	67	10.7	31
17.7.4	51.5	87	60.1	91	10.2	36
17.7.5	67.8	15	75.5	10	12.8	10
17.8.1	59.2	45	66.4	46	11.6	22
17.8.2	52.0	84	62.5	71	10.8	30
17.8.3	53.6	75	63.0	67	10.7	31
17.8.4	51.5	87	60.1	91	10.2	36
17.8.5	67.8	15	75.5	10	12.8	10

TABLE E-1 COMPARISON OF AUTOMATION INDICES FOR AIR TRAFFIC CONTROL TASKS (cont'd)

TASK NO.	GEOM. MEAN[1]		MEAN RAW SCORE[2]		MEAN Z-SCORE[3]	
	AI	RANK[4]	AI	RANK[4]	AI	RANK[4]
17.9.1	43.5	134	53.4	135	9.1	47
17.9.2	57.8	51	66.7	43	11.2	26
17.9.3	55.1	65	62.2	74	10.6	32
17.9.4	46.2	119	59.2	97	9.6	42
17.9.5	55.0	66	61.6	79	10.3	35
17.9.6	66.0	22	72.2	23	12.3	15
17.10.1	67.5	17	72.1	24	12.0	18
17.10.2	70.0	10	74.1	14	12.7	11
17.10.3	74.0	3	78.6	2	13.2	6
17.11.1	57.5	52	65.2	53	11.2	26
17.11.2	63.0	30	68.3	38	11.6	22

1. Geometric mean of raw scores by all raters for all performance capabilities in the task.
2. Arithmetic mean of raw scores by all raters for all performance capabilities in the task.
3. Arithmetic mean of converted Z-scores by all raters for all performance capabilities in the task.
4. Ranked from highest to lowest value of automation index. Because of numerical ties, there are fewer than 265 "ranks": 176 within the geometric means, 166 within the raw score means, and 68 within the converted score means.

TABLE E-2 COMPARISON OF RANK ORDER OF AIR TRAFFIC CONTROL TASKS BY THREE AUTOMATION INDICES

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
1	6.3.2	1	1
2	6.3.3	3	3
3	17.10.3	2	6
4	7.2.2	8	4
5	8.1.6	5	2
6	17.1.8	7	9
7	8.1.5	6	2
8	6.1.2	4	5
9	7.1.2	11	10
10	17.10.2	14	11
11	11.3.1	13	8
11	11.3.2	13	10
12	8.1.7	12	5
13	6.1.1	9	8
13	7.3.2	16	13
14	11.2.3	20	13
15	17.7.5	10	10
15	17.8.5	10	10
16	8.2.2	18	7
17	17.10.1	24	18
18	7.3.3	26	16
19	14.2.5	17	16
20	2.3.5	31	18
21	8.1.3	27	10
22	17.9.6	23	15
23	11.3.3	25	14
24	8.1.4	18	8
25	8.1.2	21	9
26	17.2.6	22	17
26	17.3.6	22	17
26	17.4.6	22	17
26	17.5.6	22	17
26	17.6.6	22	17
27	17.2.2	29	18
27	17.3.2	29	18
27	17.4.2	29	18
27	17.5.2	29	18
27	17.6.2	29	18
28	11.2.4	28	14

1. AI_G RANK - Rank from highest to lowest value of automation index based on the geometric mean of raw scores by all raters for all performance capabilities in the task.
2. AI_R RANK - Corresponding rank obtained by calculation of the automation index using the arithmetic mean of raw scores.
3. AI_C RANK - Corresponding rank obtained by calculation of the automation index using the arithmetic mean of converted Z-scores.

TABLE E-2 COMPARISON OF RANK ORDER OF AIR TRAFFIC CONTROL TASKS BY THREE AUTOMATION INDICES (cont'd)

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
29	9.1.3	33	18
30	17.11.2	38	22
31	6.4.2	19	6
31	7.1.4	15	7
32	9.4.2	33	15
33	8.1.8	30	13
33	9.4.1	35	16
34	2.3.4	38	17
35	7.1.5	32	13
36	14.3.5	41	25
37	7.4.1	36	16
38	16.2.6	34	10
39	2.3.3	45	23
40	12.3.2	48	22
41	7.3.1	39	17
42	2.2.4	51	21
43	14.2.4	51	29
44	14.3.6	65	32
45	5.2.3	47	18
45	17.8.1	46	22
46	14.2.3	56	30
47	2.2.1	40	27
47	6.4.1	51	23
47	6.4.3	37	12
48	2.2.3	44	26
48	11.1.1	47	20
49	12.2.1	66	28
50	8.2.1	42	19
51	17.9.2	43	26
52	17.11.1	53	26
53	8.1.1	59	24
54	9.5.3	41	16

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
54	9.5.4	52	19
55	12.1.4	68	28
56	11.4.1	51	18
57	11.4.2	49	19
57	11.4.3	57	23
58	6.2.2	60	27
59	2.2.2	55	29
59	5.2.1	62	32
60	16.2.3	50	21
61	5.2.4	60	24
61	11.2.2	63	28
61	11.5.3	64	26
62	5.3.1	52	22
62	6.3.1	39	19
63	14.2.2	72	34
63	17.7.1	63	28
64	13.1.5	57	23
65	17.9.3	74	32
66	17.9.5	79	35
67	1.2.2	69	28
67	9.1.1	46	22
67	9.3.1	63	20
68	8.2.3	73	32
69	11.1.2	64	24
70	5.1.2	54	25
71	11.5.1	83	29
72	7.1.3	60	26
73	9.5.2	55	20
74	6.1.3	56	23
74	9.1.2	58	26
74	13.1.2	73	32
75	2.1.6	63	27

TABLE E-2 COMPARISON OF RANK ORDER OF AIR TRAFFIC CONTROL TASKS BY THREE AUTOMATION INDICES (cont'd)

AI_G RANK^1	TASK NO.	AI_R RANK^2	AI_C RANK^3
75	2.3.1	71	25
75	14.2.1	61	28
75	17.7.3	67	31
75	17.8.3	67	31
76	7.4.4	65	26
77	12.2.4	87	34
77	14.3.4	73	33
78	4.3.1	84	32
78	16.2.5	69	24
78	17.2.3	76	33
78	17.3.3	76	33
78	17.4.3	76	33
78	17.5.3	76	33
78	17.6.3	76	33
79	14.3.1	78	36
80	8.1.9	70	29
80	11.2.1	64	24
81	4.1.2	63	28
81	7.2.1	74	27
82	16.2.7	77	26
83	1.1.1	95	35
83	1.3.2	89	35
84	12.2.2	92	35
84	17.8.2	71	30
85	17.7.2	73	30
86	12.2.5	103	36
87	12.3.1	94	31
87	16.2.9	89	28
87	17.7.4	91	36
87	17.8.4	91	36
88	5.2.2	88	28
89	9.2.2	75	26

AI_G RANK^1	TASK NO.	AI_R RANK^2	AI_C RANK^3
90	9.5.1	80	26
90	13.3.2	88	32
91	12.2.6	97	34
92	12.2.3	109	37
93	14.1.3	99	37
94	4.2.11	81	30
94	6.2.1	84	32
94	6.4.4	82	31
95	16.1.1	71	24
96	6.4.7	85	31
97	2.3.2	96	35
98	13.1.3	80	30
99	3.2.3	83	29
100	13.2.3	86	36
100	14.1.5	108	38
101	6.4.6	91	34
101	8.2.5	92	32
102	14.1.2	98	38
103	14.1.4	110	39
104	4.2.3	93	36
105	12.1.3	111	38
106	16.2.1	90	28
107	14.3.2	72	37
108	17.2.1	102	40
108	17.2.5	115	42
108	17.3.1	102	40
108	17.3.5	115	42
108	17.4.1	102	40
108	17.4.5	116	42
108	17.5.1	102	40
108	17.5.5	116	42
108	17.6.1	102	40

TABLE E-2 COMPARISON OF RANK ORDER OF AIR TRAFFIC CONTROL TASKS BY THREE AUTOMATION INDICES (cont'd)

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
108	17.6.5	116	42
109	4.4.3	104	38
110	17.1.5	113	42
111	2.1.2	105	40
112	16.1.2	88	28
113	9.3.2	99	31
113	17.1.6	125	45
114	4.2.4	119	42
115	17.1.1	114	42
116	14.1.1	109	38
116	16.1.3	104	31
117	3.2.2	85	27
118	7.1.1	101	34
119	3.2.1	100	32
119	17.9.4	97	42
120	12.2.7	128	45
120	16.2.2	105	29
120	16.2.4	126	37
121	4.3.4	125	43
121	12.1.1	120	38
121	13.1.1	106	39
122	2.1.1	105	42
123	14.3.3	107	40
124	4.2.2	117	40
124	13.2.1	111	40
125	2.1.3	121	42
126	15.2.4	112	35
127	3.3.1	123	41
127	4.2.6	115	40
127	5.1.1	120	41
128	2.1.4	132	48
128	15.2.2	122	39

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
129	13.1.4	119	37
129	17.2.4	115	43
129	17.3.4	115	43
129	17.4.4	115	43
129	17.5.4	115	43
129	17.6.4	115	43
130	6.1.5	129	46
130	15.2.1	127	40
130	17.1.3	138	51
131	1.2.1	133	43
132	4.2.10	124	43
133	4.4.4	130	46
134	17.1.7	131	46
134	17.9.1	135	47
135	6.4.5	127	41
136	17.1.2	144	52
137	13.2.2	118	40
138	9.5.6	128	41
138	12.1.5	131	41
139	1.3.1	138	44
139	8.2.4	144	48
140	15.1.2	137	45
141	15.2.5	134	43
142	1.1.3	139	47
142	7.4.3	127	39
143	11.5.2	137	47
143	16.2.10	148	49
144	2.1.5	143	52
145	1.1.2	148	47
145	15.2.3	138	44
146	4.1.1	130	42
147	4.2.5	142	50

TABLE E-2 COMPARISON OF RANK ORDER OF AIR TRAFFIC CONTROL TASKS BY THREE AUTOMATION INDICES (cont'd)

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
147	4.2.9	146	52
148	4.3.2	141	49
149	3.3.2	147	48
150	5.1.3	132	42
151	12.3.4	141	46
151	15.1.1	150	51
152	4.2.1	142	50
152	15.2.6	142	47
153	16.2.8	149	48
154	4.2.8	146	48
155	3.1.1	136	43
156	1.3.3	144	48
156	13.3.1	146	54
157	5.3.3	145	45
158	12.1.6	153	57
159	4.2.13	151	55
160	12.1.2	156	57

AI_G RANK[1]	TASK NO.	AI_R RANK[2]	AI_C RANK[3]
161	6.1.4	140	46
162	12.1.7	159	60
163	17.1.4	157	61
164	12.3.3	153	55
165	4.2.7	155	60
166	4.4.1	158	58
167	9.5.5	152	53
168	3.1.3	164	66
169	3.1.2	160	64
170	5.3.2	154	56
171	4.2.12	162	65
172	7.4.2	160	59
173	4.3.3	161	62
174	9.5.7	163	63
175	3.3.3	166	67
176	4.4.2	165	68

APPENDIX F
STATISTICAL PROCEDURES AND FORMULAE

With two possible exceptions, the statistical procedures that were used in the analysis of the data were quite simple.

Raw score data were treated as discrete scores (i.e., were not grouped) in the basic computation of the arithmetic mean, standard deviation (S.D.) and standard error of the mean (SEM). The formulae, in these instances, were as follows:

1. $M = \frac{\Sigma X}{N}$

2. $SD = \sqrt{\Sigma (X-M)^2/N-1}$

3. $SEM = \frac{SD}{\sqrt{N}}$

The computation of the geometric mean of the raw scores per task used the same data base, where the process is the n^{th} root of $X_1 \cdot X_2 \cdot X_3 \cdot \cdots \cdot X_n$. This is one of the two unusual statistics. It has the advantage of reducing the essentially spurious correlation between mean and variance that is otherwise present in judgmental ratings with arbitrary scale values.

The computation of the converted scores was, again, conventional. Each raters scores were first aggregated on each capability dimension and the SD was computed for that dimension. A standard score was derived from each raw score by the process:

$$Z = \frac{X - \overline{X}}{SD} \quad ,$$

where $\overline{X}$ is the arithmetic mean by capability for a given rater and SD is the standard deviation for that specific distribution. The resulting Z scores were grouped into 20 class intervals and converted to a standard scale from 1 to 20 to eliminate negative values and decimal fractions. The converted scores (C) were then aggregated for each task in the same way that the raw scores were aggregated.

The checks on the influence of occupation and educational background upon rater predilections was accomplished by use of conventional analysis-of-variance techniques where:

$$F = \frac{\sum_{1}^{K} n_i \, (\overline{X}_i - \overline{X})^2 / df_{BG}}{\sum_{1}^{K} \sum_{1}^{n_i} (X - \overline{X}_i)^2 / df_{WG}}$$

Differences in the n_i factor (group size) are not a problem in one-way analysis-of-variance computations where the between-groups score of squares is:

$$\frac{\left(\sum_{1}^{n_i} X_1\right)^2}{n_i} + \frac{\left(\sum_{1}^{n_i} X_2\right)^2}{n_i} \; . \; . \; . \; . \; - \frac{\left(\sum_{1}^{n} X\right)^2}{n}$$

and n_i is free to vary. The only problem with this approach is the affirmation of the null hypothesis as an issue. In the present instance, what could be said is that individual differences between raters were greater (in one test) or nearly as great (in the second test) as differences between raters grouped by occupation or educational beckground.

A similar logic was used in the diagnosis of problem tasks where relatively low confidence was assigned to task ratings which had high SD or SEM statistics. The objective was to determine whether the variance was attributable primarily to rater disagreement (lack of consensus) or to differential scores assigned to capabilities within the same task. The F-ratio in this instance simply permitted a determination of which source of variance was the larger. No specific 'test of significance' was done since none was required.

The statistic for determining interrater reliability is somewhat unusual. The computation is basically a form of multiple correlation where the abscissa is a simple ordering (as in Rho) and the outcome depends on the variation of actual scores around a composite score at each position in the ordinal scale.

The formula is a variation on the Spearman-Brown Rho proposed by Ebel and described by Guilford, as follows:

$$R_R = \frac{V_T - V_E}{V_T}$$

where R_R is the analog of Rho, V_T is the variance attributable to tasks (in the present case) and V_E is error variance. The data base was composed of the average converted score per task per rater. The data base is organized as a matrix of raters (27) and tasks (265). The computation includes a calculation of all marginal sums of squares and is similar in outline to a two-way analysis of variance. It provides a composite datum having approximately an _r_ distribution. Again, no significance test was required.

APPENDIX G

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