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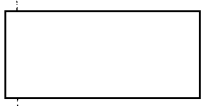
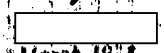


Personnel and Automation in Soviet Air Traffic Control

A Scientific Intelligence Assessment



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Personnel and Automation in Soviet Air Traffic Control

Central Intelligence Agency
National Foreign Assessment Center

March 1978

PREFACE

In the past few years the Soviets have been studying ways to improve the quality of their civilian air traffic control services in terms of increased capacity, decreased delays, expanded geographical coverage and improved conditions for greater flight safety. They are improving their hardware and are strengthening their controller personnel program.

This report examines current Soviet practices with respect to personnel aspects of air traffic control. Personnel recruitment, selection procedures, and training programs are reviewed. Where appropriate, the impact of a newly obtained Swedish air traffic control system on these factors and on air traffic controller activities is evaluated.

Since the Soviet air traffic control system is under direct military control during military crisis situations, these changes are of particular concern. Possible benefits to Soviet air defense hardware developments from imports of Swedish air traffic control technology were discussed in a previous study: Automated Air Traffic Control in the USSR, 31 August 1977, [redacted]. The present report supplements the previous one with respect to the status and trends in personnel aspects of Soviet civil air traffic control system.

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SUMMARY AND CONCLUSIONS

The Soviets recently purchased an automated air traffic control system (TERCAS) from Sweden that is to be installed and operational by January 1979 at four air traffic control sites—three terminal control centers and an area control center. While the automated equipment will be installed at only a small number of sites, these sites have high traffic density. Several factors evidently stimulated this purchase: (1) projections of continued increases in domestic as well as international air operations over the next decade; (2) the Soviet fear of a major aircraft accident during the 1980 Olympics in Moscow; (3) the Soviet membership in the International Civil Aviation Organization (ICAO) since 1970, which has necessitated a number of changes in the air traffic control system and, (4) possible use by the military during crisis situations.

The introduction of automated equipment will improve significantly the processing and handling of radar data and the recording of flight plan data. These improvements will aid the controller in some decisionmaking responsibilities and should have the immediate effect of increasing the number of aircraft an operator can control safely.

Concurrently with the planned introduction of new equipment, the Soviets are strengthening their air traffic control personnel program. They apparently are satisfied with recruitment procedures but have introduced several modifications to the selection process and the training program. A recent significant modification involves the addition of a psychological test apparently intended to identify individuals who are unable to function reliably in high stress situations. This step represents a departure from the Soviet position of the past 30 years concerning psychological testing and very likely stems from increasing concern over operator performance during conditions of high traffic density.

As in many areas requiring specific skills, the Soviets educate their controllers in a comprehensive 33-month program that includes subject areas other than air traffic control. This program appears to provide the equivalent of a college degree, but in subjects dealing directly with air traffic control, the scope of the academic education is comparable to that given to US controllers. A recent change in the training program has been an increase in the use of simulators, which should not only facilitate transfer of training to the job but decrease training time and increase operator reliability as well.

When the Swedish system is introduced, the composition of Soviet air traffic control teams at the terminal control center will remain unchanged. A control position, however, will be added at the area control center for metering and spacing aircraft. This control position should improve system efficiency in that it allows timely action to be taken in the area control center to avoid overloading terminal controllers.

The introduction of automated equipment and the modifications to the personnel program should have the net effect of strengthening the controller training program and decreasing the probability of operator error.

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DISCUSSION

INTRODUCTION

Air traffic control (ATC) in the USSR is currently undergoing significant changes. Until 1976, Soviet ATC was largely a nonautomated operation. In an effort to handle the number of high performance aircraft and continuing increases in air traffic volume, the Soviets have focused on improving air traffic control procedures including moves toward automating air traffic control, utilizing computers and electronic displays to aid the controllers.

The Soviets recently have negotiated with the Swedish company, Stansaab, for an automated terminal and enroute control system (TERCAS). TERCAS initially will be installed at four operational ATC sites—three terminal control centers (TCC) in Moscow, Kiev, and Mineral'nyye Vody and an area control center (ACC) adjacent to the Moscow TCC.* The Soviets also have placed into operation in Leningrad what is purported to be a prototype Soviet-designed semiautomated ATC system (START), but no firm evidence is available to indicate that further production is planned.

Concomitant with the decision to purchase hardware, there has been a renewed interest in the ATC personnel program. The Soviets have a continuing concern with aviation safety and are particularly concerned about the possibility of a major incident occurring during the 1980 Olympic Games attributable to inferior equipment or poorly trained controllers. Ministry of Civil Aviation officials labeled the former training program inadequate and called for new and effective methods of training.

The Soviet entry into the International Civil Aviation Organization (ICAO) in 1970 also led to a number of changes in the ATC system that have a direct impact on personnel training. For example, according to a ministerial official, since Soviet entry into ICAO, it has been necessary to renumber airways and to rework the "tables of communication" for air traffic on domestic and international routes.[2] Controllers, of course, would be required to assimilate these changes. The Soviets recently have requested manuals on phraseology and probably are going to retrain their controllers to use the standard ICAO recommended phraseology.[1]

Current reports indicate that the Soviets are reevaluating their entire personnel program. This includes personnel recruitment, selection procedures, and training. Additionally, the introduction of TERCAS will affect controller activities which, in turn, may influence selection and training programs.

RECRUITMENT AND SELECTION

Recruitment procedures for Soviet ATC operators* will continue to parallel closely those used for civil aviation pilots and will be unaffected by the introduction of TERCAS. DOSAAF aeroclubs are a prime source of new recruits, but civil aviation recruiters also work through schools and labor organizations.[3] Recruits often are obtained as a result of advertisements placed in Aeroflot publications and special announcements posted in secondary schools. Undergraduates from ATC schools who lecture to secondary school graduating classes are believed to provide an additional source of recruitment. Since a career as a controller is considered highly desirable, recruiters are reported to experience little difficulty filling their quotas.

The current techniques for selecting controller candidates, although generally similar to those used for the selection of civil aviation pilots, also incorporate several changes. One change has been the inclusion of personality tests.[3,4] The renewed interest in personality tests is relatively recent in the Soviet Union. Lacking an established test development

*The Moscow area control center exercises control over the Moscow Flight Information Region. The Moscow terminal control center (TCC) has the responsibility for the control of aircraft that fly to and from Moscow's airports. Moscow TCC, therefore, has direct data communication both with the ACC and with the airport control towers. The Kiev and Mineral'nyye Vody TCC are equivalent in function to the Moscow TCC even though their traffic densities are lower.

*Controllers are divided into "first and second tier." First tier controllers are personnel who communicate directly with and control aircraft; second tier controllers are supervisors and flight operations managers. For purposes of this report, "ATC operator" will refer to first tier operators unless otherwise designated.

program, the Soviets are reported to be administering translated versions of the Minnesota Multiphasic Personality Inventory (MMPI).[3] Although it is not known whether this test has been validated for the indigenous population, it appears that the Soviets regard the MMPI as a useful diagnostic tool to identify individuals unable to perform under high stress conditions.

A spatial relations aptitude test also has been incorporated into the selection process. This test probably is similar to those used in the US that test the controller's ability to visualize objects and forms in three dimensional space. The task, for each item, is to indicate the number of the depicted solid figures that can be made from an unfolded pattern. US experience has been that this type of test is one of the more reliable predictors of success in ATC schools.

These two tests are additions to the standing requirement that controllers be male, between 17 and 26 years of age, have completed secondary school and pass general aptitude tests.[3 4] Once applicants have completed the test battery, they are scheduled for a complete medical examination and security investigation. As in the case of pilots, the medical examination is a significant factor in screening inasmuch as applicants can be rejected solely on the basis of the medical examination while allowances are often made for poor or marginal performance on the other selection measures.[3]

TRAINING

The Soviets have a centralized approach to controller training in that approximately 90 percent of the training is conducted at one of four civil aviation institutes; the remaining 10 percent is conducted on the job."* According to a leading Soviet civil aviation training official, the Soviets opted for centralized training rather than extensive "on the job" training because of lack of equipment, manpower, expertise, and standardization necessary for on-site training.[4]

The Soviets apparently have two separate ATC training programs, one for pilots and a second for those who have had no pilot training. The training for pilots is relatively short, consisting of a 45-day course followed by five to six months of laboratory workshop.[5 6] The second training program, which is administered to the great majority of students, is a 33-month program conducted at one of the primary training facilities.[4] For purposes of this report, all references to controller training refer to this second program

The primary ATC training facilities are the civil aviation institutes at Riga, Ulyanovsk, and Kirovograd and the Leningrad Civil Aviation Academy. Students receive room, board, uniforms, and a monthly monetary allowance.

The program includes three main groups of disciplines: general scientific (history of the Soviet society, philosophy, higher mathematics, and physics); aviation (aerodynamics and design of aircraft); and subjects directly related to ATC (principles of ATC, organization of ATC). Thus, the Soviet controller receives a broader education than his US counterpart; in subjects dealing directly with ATC, however, the training is considered by some Western sources to be comparable.[5 7 8 9]

The Soviets use electronic response systems to record individual responses to questions presented orally or visually to the class by the instructor. While this technique is not new, it facilitates the learning process by permitting all students to answer questions simultaneously and identify for the instructor the level of comprehension achieved by the class. The instructor thus can give immediate feedback to students concerning their performance.[10 11]

The initial cadre of TERCAS controllers will be trained by Stansaab at a facility in Sweden.[12 13 14] The Stansaab contract also calls for a simulation facility to be built in the Soviet Union for the subsequent education and training of traffic controllers as well as for testing and improving technical traffic procedures.[12] Stansaab officials estimate that this facility will have an educational capacity of about 80 prospective controller trainees a year.[14] This simulation facility, which will be located at the Vnukovo airport in Moscow, will house numerous controller and pilot consoles.[12] Furthermore, according to a description of the equipment to be supplied by Sweden, a "special function" for training air traffic controllers will be provided at the terminal control centers in Kiev and Mineral'nyye Vody, implying that simulation equipment may be installed at these sites also.[12]

The TERCAS simulator provides the same types of displays as the actual equipment and is reported to be programmed to create in a realistic environment any desired air traffic situation.[13] The student will be able to distinguish between those aircraft equipped with

*By way of comparison, in the US, approximately 8 percent of a controller's training is conducted at the FAA Academy in Oklahoma City and the remaining 92 percent is conducted on the job at one of the several hundred ATC facilities throughout the country.

transponders and those not so equipped, thereby allowing him to plan interrogations. The use of a simulator allows the student controller to practice responses to widely varied situations and facilitates transfer of training from classroom to job.

There is conflicting information regarding exactly when on job training is introduced in the curriculum. According to some reports, it is reserved until the completion of all coursework at the end of the fourth year. Other reports indicate that such training is interspersed with classroom training during the third and fourth years.[9] Given the length of the Soviet program, the proportion of time spent in a classroom environment and the overall training objective of reinforcing lecture material, the difference in reports probably reflects the simulation capability of a particular training institute. Institutes having radar simulation capability probably relegate on-the-job training to the end of the curriculum while institutes without a radar simulation capability intersperse this training with the course curriculum.

The Soviets are also reexamining methods to evaluate a controller's performance during training.[9] No information is available on exact performance criteria used, but categories on which controllers are evaluated are similar to those used in the United States.[15] For example, current evaluation categories include the following: (1) fundamentals of ATC such as principles of flight, phraseology, and meteorology; (2) non-radar ATC such as the ability to complete area charts labeling center boundaries and navigational aids; and (3) radar ATC such as the sequencing of aircraft approaching a handoff position. Emphasis is placed on the controller's ability to visualize the interrelation—in space—of aircraft traveling in different directions, and at different speeds and altitudes. The difficulty of this sort of spatial visualization may be one of the reasons why the Soviet ATC curriculum includes 60 hours of flight instruction.

An innovative process has been introduced by the Soviets to evaluate the effectiveness of this training program. Airport facility managers are required to provide performance feedback to an institute on each of its graduates. This feedback is intended to provide information that will indicate where training is inadequate and where increased emphasis is required. The information also may serve as a criterion to validate the selection procedures.

The Soviets do not rely upon selection tests and training techniques alone to provide capable controllers. Controllers are covered under a civil aviation medical program, which is strongly oriented toward preventive techniques. At the Vnukovo airport in Moscow, controllers now receive preshift examinations that require little time and can be easily administered by paramedics. These examinations include an electrocardiogram and measures of pulse rate, blood pressure, body temperature, and alcohol vapor in exhaled air. Data are entered into a computer that issues a readout comparing the measures with prestored "normal" values for each individual. In addition, controllers are given two reaction-time tests. These tests are designed to measure an individual's ability to coordinate perceptual and motor abilities and include an oculomotor reaction and tracking test. These tests appear to have a reasonable amount of face validity. The system is still in the trial phase; data are being collected to support the validity and practicality of installing such preshift testing on a large scale.[16 17]

TEAM COMPOSITION

ATC teams are divided into two categories—those who work at the terminal control centers and those who work at the area control centers. Area control centers employ a larger number of controllers because they are responsible for a larger section of the airspace. For both, the number of controllers assigned depends on the division of the airspace and the traffic density.

The introduction of automated equipment should have little impact on the team composition at terminal control centers. These centers will remain staffed by arrival/departure controllers, approach/final controllers, assistant controllers, and flight data specialists.

The area control centers will continue to be staffed by radar controllers, procedural controllers, and assistant controllers. A significant addition to the area control center manning will be that of a controller responsible for the metering and spacing of aircraft.[18] In the US, this controller is referred to as a flow controller or a coordinator, depending on the area of responsibility. The basic objective of flow control is to regulate the flow of air traffic so that it does not exceed the maximum number of aircraft that can be accommodated safely within a given airspace. This position is commonly added to ATC teams operating in high density areas. The addition of this position at the Moscow ACC should improve system efficiency in that it allows timely action to be taken in the area control center so that the terminal controllers are not overloaded.

As in the West, the skill levels for both terminal and area control centers range from the highest skilled controllers, those who are responsible for separation assurance and who have direct communication with aircraft, to specialists who perform support functions. Unlike in the US, controllers in the Soviet Union are not rotated between the radar room and tower. The rotation of controllers among different positions within the radar room is for longer periods of time than for their US counterparts.[3 18] The purpose of controller rotation is to relieve radar controllers whose positions place them in a constantly demanding situation. Given the low density of Soviet air traffic, it may be that the controllers have not required frequent rotations.

CONTROLLER ACTIVITIES

Introduction of TERCAS will significantly improve the processing of radar data and the presentation of these data to controllers. This feature should in turn decrease the probability of controller error.

Radar controllers at the enroute and terminal facilities will perform the same functions using TERCAS as they did using the nonautomated system. The jobs will be changed mainly in terms of the types of information displayed that must be assimilated by the controller and the methods of recording and communicating information.

For example, terminal control center arrival/departure and approach controllers and area control center radar controllers have to assimilate and organize all pertinent data on positions and tracks of aircraft in order to assure safe separation between aircraft in their respective control jurisdictions. Although this responsibility will still be present when TERCAS is used, the type of information appearing on the radar scope assists the operator in aircraft identification and flight path predictions. TERCAS provides for automatic tracking of transponder-equipped aircraft and automatic flight plan probes to identify conflict-free paths.[13] This function goes beyond the mere organization of data (as in the preparation of flight strips) to aiding the controller by checking separation assurance. The display of secondary surveillance radar data depends on the extent to which aircraft in the traffic environment are equipped with the necessary airborne transponders. It is believed that 25 to 40 percent of Soviet civil aircraft are not equipped with transponders. Nevertheless, comments by Ministry of Civil Aviation officials indicate that these figures will decrease significantly during the next couple of years.[8 14 20]

The heart of TERCAS is the Censor 900 computer system that as part of its functions, supports an advanced graphic display. Secondary radar displays of aircraft altitude, computer derived airspeed, and either a transponder code or aircraft call sign will be displayed on the radar scope alongside the appropriate target.[2 13 14] Controllers using the Soviet automated system (START) receive information on fuel remaining and airport destination.[21] Similar information probably will be presented on the TERCAS displays since Soviet civil aviation officials emphasize the importance of this type of information.

Using TERCAS, the controller can obtain a predicted position for selected aircraft based on a linear extrapolation of flight path data.[13] This position prediction capability and an automatic tracking capability for transponder-equipped aircraft make automatic collision prediction or conflict alert a logical next step for inclusion in TERCAS. A conflict alert probably would not be generated more than two minutes in advance since doing so would increase the likelihood of a false alarm. A conflict-alert capability would aid the controller and increase flight safety by assisting the controller in one type of decisionmaking task.

The communication procedure for transferring aircraft control responsibility from one sector to another (hand-off) will be changed significantly by the introduction of automated equipment. Previously controllers engaged in a great deal of interphone communication to coordinate handoffs. In TERCAS, the handoff procedure has been automated; coordination between controllers is effected by each controller depressing keys on his console to indicate transference or acceptance.

The TERCAS equipment also will bring changes in the tasks of the flight data assistants. Previously, flight plan and aircraft track information were recorded manually using a time-distance plotting method.[22 23] The chart, which was about 30 inches square, was the primary means by which the controller kept track of the flight activity in his sector. This manual method can become very cumbersome in high traffic density areas and, therefore, has been replaced by strip marking procedures in TERCAS.

It has been Western experience that the flight strip is an effective device even though it requires many manual operations. The strip must be torn from printers, stuffed in holders, placed in strip bays, passed between positions, marked for bookkeeping and record purposes, and manually counted to develop facility

traffic statistics. The system organizes portions of each flight plan in accordance with the established sectors of responsibility; for each sector a flight strip is printed including the aircraft's time of arrival to or departure from the sector. Controllers usually mark the strips with special symbols denoting their control actions. US experience has been that this practice often detracts from time that could be spent on other control functions. Consequently, research is being conducted on direct "touch" displays where a simple touch by a finger on the controller display will cause the immediate display of a full flight plan. The Soviets are aware of this research but have indicated that they prefer the manual strip method since it provides a legal record of control transactions.[22] Rather than overload the radar controller with this task, however, they have relegated this responsibility to a "procedural controller."

The introduction of TERCAS will aid the controller in some decisionmaking responsibilities and also should have the immediate effect of increasing the number of aircraft an operator can control safely.

This report was prepared [redacted] the Office of Scientific Intelligence. Questions may be addressed to [redacted]

REFERENCES

The source references supporting this paper are identified in a list published separately. Copies of the list are available to authorized personnel and may be obtained from the originating office [redacted] *through regular channels. Request for the list of references should include the publication number and date of this report.*