PART 1
The Study

OVERVIEW

Despite international concern over the potential risks posed by the state of the Russian nuclear and missile complex, little hard evidence has been available to assess actual migration rates and their possible impact on prospects for international proliferation. In 1999 the Carnegie Moscow Center undertook to fill the gap in the study of migration from the nuclear-missile centers by commissioning this sociological field study, which was conducted in three nuclear and three missile cities. In particular, the migration potential of the cities in question was studied.

The results presented here stem from a number of surveys done as part of a larger project that analyzes the effects of migration on national and international nuclear security. It continues research begun in 1992 on potential and real migration of nuclear and missile scientists and specialists.[1]

This report provides heretofore unavailable information on and analysis of the problems confronted by Russian high-tech industries. The onset of concerns over the brain drain coincided with the transformation of the Russian political and economic system, including the reorganization of the Russian defense industry. Our study focuses on the migration of personnel in nuclear and missile industries and its detrimental consequences on national and international security.

The study is based on official statistics and detailed surveys. It analyzes several aspects of migration patterns, including:

- How and why people in these industries migrate;
- Migration of specialists to closed and open cities where nuclear and missile facilities are located;
- The potential and actual emigration of weapons specialists out of Russia;
- The private sector's absorption of nuclear and missile experts; and
- The training of incoming personnel by nuclear and missile industries.

[1] For the purposes of this paper a specialist is a person who has received a higher education and occupies an executive, administrative, or scientific post in certain organizations.

STUDY RESULTS

The study produced some surprising results. On one hand, the subjects expressed less desire to emigrate from Russia to other countries than in the early 1990s. The bulk of acknowledged migration during this time was to Israel, Germany and the United States, countries that do not represent a threat to Western security interests. The study did not discover a single instance of a departure for such problem countries as Iraq or Iran. On the other hand, the emigration potential in the nuclear-missile complex remains dangerously high. The situation is exacerbated by the fact that there was no significant improvement in the overall conditions in the enterprises during the 1990s. As a result, while many of the experts were hoping at the start of the decade that the bad times would soon pass and the situation would improve, those hopes had been all but extinguished by the end of the decade. This state of affairs objectively has to push people in the direction of accepting offers of work, regardless of the source.

Therefore, it would be a mistake to take the absence of documented brain drain cases to states of proliferation concern during the previous decade as a guarantee that there will be no such problem in the future. In a certain sense, the prevailing disappointment and hopelessness in the nuclear and missile centers more likely points to a growing risk of proliferation, even though a number of formal statistical measures might indicate the reverse.

Why should the migration of nuclear and missile experts from the cities be a cause for concern? And why are concerted state policies needed to address these issues? There are a number of reasons:

- The abundance of nuclear materials in the closed cities is at risk of being unlawfully sold on the open market, thereby exacerbating the problem of nuclear weapons proliferation;
- Under current conditions there is an equally disturbing possibility that nuclear and missile specialists could be exploited by countries seeking expertise to develop their own nuclear weapons and missiles;
- Nuclear missiles still exist, and specialists are required to maintain and improve their safety and security;
- The dismantling of nuclear weapons is a time-consuming and demanding process requiring the mastery of those specialists who were involved in the weapons' development and production.

In short, the distinctive services and expertise of specialists in the nuclear and missile cities will be in demand for many years, and their potential migration poses numerous security problems for Russia and the global community.

Sources within the industrial cities maintain that, for the time being, the impact of expert migration is under control. Yet the best remedy for missile- and nuclear-related transfers and emigration of specialists to aspiring nuclear countries is to increase salaries and improve job satisfaction, neither of which the Russian system can currently do. According to our study, the attitude of specialists toward their work is changing. In 1992, 20 percent of the specialists surveyed said they were proud of their work in the defense industry; in 1993, this figure had fallen to 15 percent. Certainly the figure is even lower by now. Sense of pride in work as a guard against the leakage of classified missile and nuclear know-how, including manpower and materials, is no longer reliable.

The missile and nuclear infrastructures will continue to exist for the foreseeable future, although possibly modified in size and scope. Well into this decade and beyond, hundreds of thousands of Russian citizens will depend on this facet of the military-industrial complex. Consequently, the Russian government and associated experts have a responsibility to

understand the particular social and economic problems that beset these specialists at a time when Russian reforms are evolving. The better these trends are understood, the more effective targeted programs to address current circumstances will be.

Balance of Migration. In order to maintain their capabilities, nuclear and missile industries require a balanced inflow of a highly skilled and specialized work force to match the skills and numbers of people leaving the centers. The missile and nuclear cities are unable by themselves to provide the number of specialists required to support their large-scale civilian and military activities. Inevitably, some of the manpower must be trained and hired from outside the cities, a common practice in the past. As the departure of skilled specialists threatens the efficient operation of the nuclear and missile complexes, ensuring an inflow of experts into the affected cities becomes a matter of Russian national security. Yet at the very time that current economic circumstances are fueling migration out of the cities, the qualities that formerly attracted new talent to the cities have all but disappeared.

In the interest of national and international security, it is imperative to strike a balance between the migration into and out of the nuclear and missile cities. This balance must take into account both the number and level of expertise of the personnel. The right balance will be one that maintains the security of the nuclear and missile facilities while retaining adequate defense capabilities. This study aims to identify the predominant factors determining the migration of nuclear and missile specialists.

PLAN OF THE STUDY

In addition to studying the actual and potential migration to and from nuclear and missile centers, this study analyzes the general situation of labor markets in the subject cities and in Russia as a whole, as well as the dynamics of living conditions in nuclear and missile cities. Furthermore, the study examines the transfer of specialists from the private sector and the challenges involved in training new employees at the nuclear and missile complexes.

The problem of personnel formation and personnel mobility within the missile and nuclear complex was also reviewed to evaluate its impact on the safety of the Russian military capabilities and to examine potential and real emigration of missile and nuclear complex experts.

In support of this project, the study also relies on official statistical data in a comprehensive database. The sources of the official data are the Russian Ministry of Atomic Energy (Minatom), the Federal Employment Service, the State Statistical Committee of Russia, and the results of specially commissioned sociological surveys conducted in the nuclear and missile industries in 1992 and 1999. These surveys were carried out through the auspices of the Russian Academy of Sciences on the ground at nuclear and missile enterprises throughout Russia.

The objectives of the study are:

- To examine the mobility trends of personnel in the Russian missile and nuclear complex and to define the negative trends in the hiring of new employees. These topics cover the following:

1. overall professional qualifications;
2. age and gender of personnel;
3. professional characteristics of those applying for jobs and those leaving the industry;
4. sources of employee inflow and quality of newly hired staff;
5. reasons for employee dismissals.

- To analyze the structure and scale of potential and real emigration of specialists, including:

1. the direction of and conditions that induce emigration;
2. the possibility of experts' emigrating to "rogue states";
3. the factors that hinder or facilitate this process.

The surveys for this study were conducted in enterprises located in five of the ten closed nuclear cities under Minatom's jurisdiction and three missile plants in open cities.

The Sampling Method. The surveys were conducted in person by two teams in June and July, 1999, at the working facilities of the people surveyed. The locations were chosen in order to cover all types of specialization. For the nuclear cities, this included research centers, production centers, and chemical centers, and for the missile enterprises, predominantly civilian space research, military missile production, and missile development facilities.

Within each facility a quota was determined (90–100 persons per facility). The size of the quota was determined by funds available for the survey and by the need to have a statistically significant survey. Within the facility, the quota was distributed among several subdivisions proportionally to their share in the overall quantity of the experts at the facility. Inside the subdivision, the participants were selected randomly.

The participants were not paid for their participation in the survey. The selected participants were so thankful for an opportunity to talk about their life to "people from Moscow," who during recent years had seemed so far removed, that they were very cooperative and there was no need for additional financial motivation.

SAMPLE SURVEY: NUCLEAR SITES

Our sample survey represents the profile of the closed cities as a whole. As table 1 shows, two of the ten closed cities (Sarov and Snezhinsk) specialize in scientific research, three (Lesnoy, Trekhgorniy and Zarechniy) host serial production of nuclear munitions, and five contain various chemical enterprises supporting the nuclear industry.

Table 1. Specialization of closed cities

CITY	SPECIALIZATION
Sarov	Scientific research, the Federal Nuclear Center
Snezhinsk	Scientific research, the Federal Nuclear Center
Trekhgorniy	Serial production of nuclear munitions
Lesnoy	Serial production of nuclear munitions
Zarechniy	Serial production of nuclear munitions
Zelenogorsk	Chemical industry complex
Ozersk	Chemical industry complex
Novouralsk	Chemical industry complex
Zheleznogorsk	Chemical industry complex
Seversk	Chemical industry complex

The sampling method for the study was applied in each category of city (scientific research center, plant producing nuclear munitions, chemical center). The final set included Sarov and Snezhinsk (scientific research centers), Seversk (chemical center), and Zarechniy and Trekhgorniy (production centers).

The survey was conducted among one hundred working specialists at each major enterprise located in the selected cities. All received higher education and occupy managerial positions in scientific research and engineering. The study also surveyed twenty employees who had either left or joined the five enterprises in 1999.

Table 2. Working and surveyed specialists in selected closed nuclear cities

TOWN	UNIVERSE	SAMPLE	PORTION OF SAMPLE, %
Sarov	10000	100	1.0
Snezhinsk	5700	100	1.8
Seversk	4500	100	2.2
Zarechniy	4200	100	2.4
Trekhgorniy	2000	100	5.0
Total	26400	500	1.9

In addition, a survey was conducted among thirty final-year students at each of five institutions of higher education that specialize in training personnel for the atomic industry: in the Moscow region, Moscow Physical Technical Institute in Dolgoprudniy; in Tula, Tula State University; in Chelyabinsk, South Ural State University; in Sarov, Sarov Physical Technical Institute; in Obninsk, Obninsk Institute of Atomic Power Engineering.

SAMPLE SURVEY: MISSILE SITES

The sample represents the major enterprises of the missile industry, including both those researching and implementing peaceful uses of outer space and those manufacturing strategic missiles and designing submarine-launched missiles.

Our survey included eighty working specialists at each major enterprise located in the three selected towns. All have a specialized higher degree and occupy positions in scientific research, engineering, and administration. The survey also covered twenty employees who had either left or joined the three enterprises in 1999 (table 3). In addition, a survey was conducted among thirty final-year students at each of three institutions of higher education that specialize in training personnel for the missile industry: in Moscow, Moscow State Technical University in Bauman and the Forestry Technical University in the Mytischi; in St. Petersburg, the Mechanical Institute.

Table 3. Working and surveyed specialists in the missile industry

CITY	ENTERPRISE	ENTERPRISE SPECIALIZATION	UNIVERSE	SAMPLE	PORTION OF SAMPLE, %
Miass	Rocket Center: Makeev Design Bureau	Designing submarine-launched missiles	500	80	17
Votkinsk	Votkinsk Machine Building Plant	Production of "Topol" ballistic missiles	1700	80	5
Korolev	Korolev Rocket and Space Corporation	Outer space systems, orbiting stations	10000	80	0.8
Total			12200	240	2

FINDINGS

NUCLEAR CITIES

The Russian nuclear complex is made up of ten "closed" nuclear cities spread across the Asian landmass. The skills of the estimated 120,000 workers in these cities were essential to the development of Russia's nuclear arsenal, and would be very useful to other would-be nuclear-weapon states. Almost 2 percent of the work force in five of these cities were surveyed for this report, and the major findings are as follows:

Overall Migration

- Between 1989 and 1999, the estimated overall migration inflow to closed cities amounted to seventy-nine thousand people, or nearly eight thousand people a year. There is a marked reduction both in the absolute value and in the rates of migration inflow to closed cities. This indicates that, while closed cities remain attractive to migrants, the attraction is diminishing rapidly. There are reasons to believe that in two or three years migration to closed cities will reach a zero value, and then quite probably an outflow of population will begin.
- Migration of specialists to closed cities reached its peak in the early 1980s, and then began to decrease. The decrease was accompanied by an increase in the number of permanent residents among the specialists who began to work in closed cities, and this growth noticeably accelerated in the 1990s. The 1990s saw an explosion in the share of closed cities' permanent residents taking jobs at the enterprises, from 24 percent in the 1980s to 65 percent in the 1990s.
- The pattern of migration flow is changing. Before 1990, residents of open cities accounted for more than 80 percent of migrants, and in 1990 residents of closed cities who had studied in open cities formed two-thirds of the migration flow. In the 1990s, there was relatively little migration from open cities. Those who formerly had moved to closed cities to work are being gradually and, of late, ever more rapidly replaced by local residents.

Specialists' Recruitment

- The 1990s marked a turning point in the pattern of personnel recruitment in closed cities. Today nearly 90 percent of specialists working in closed cities are local residents. This represents a sharp contrast with the 1970s and 1980s, when only about one-third of specialists starting work in closed cities were local residents.
- The closed cities' own demographic potential grew sharply (nearly 4.5 times) in the 1990s over the 1980s. Such substantial growth in the cities' own labor resources has been a decisive factor in reducing migration inflow into closed cities. This process was further intensified in the 1990s by a substantial reduction in demand for specialists by state enterprises.
- The reduction in state enterprises' demand for specialists, combined with a demographic explosion, has led to the present situation in which unemployment among working-age residents of closed cities is 10 percent. The expected continuation of the demographic explosion in the first decade of the twenty-first century means that either the state enterprises take advantage of the favorable situation and carry out a substantial rejuvenation of their personnel or the cities will be faced with high numbers of unemployed youth and with all the ensuing negative consequences of that turn of events.

Qualifications of Specialists

- The 1990s saw very serious negative changes in key personnel. Not only was there a reduction in the percentage of staff members holding an academic degree, but the source of their degrees also changed. Before 1990, practically everyone holding an academic degree earned it while working at the enterprises. People's work at the enterprises provided them with material for a dissertation. In the 1990s, practically no dissertations were defended at the enterprises, and persons with academic degrees had to be recruited to the enterprises. This is an indication of the gradual disappearance of scientific life at the surveyed enterprises.
- In an overwhelming majority of cases, specialists for closed cities were trained at educational institutions in Russia. The disintegration of the USSR has not affected the system of personnel training. All major educational institutions offering instruction in the atomic fields have remained in Russia. In the 1990s there was a sharp increase in an adverse trend—a rapid growth in the share of specialists receiving an education in closed cities themselves or in the regions where closed cities are located. There was a particularly marked drop in the share of specialists who obtained an education in Moscow and the Moscow Region, where the leading educational institutions are located. This adversely affects the professional standards of specialists. Among graduates holding academic degrees from institutions of higher education, the share of those from schools located in Moscow and the Moscow Region is about five times greater than those who graduated from institutes in closed cities, and three and a half times greater than those who obtained a higher education in the regions where closed cities are situated.

Age of Specialists

- Current trends in personnel movement are unfavorable to state enterprises. If they persist in the future, the average age of employees in the work force will increase even more. This will happen through an increase in the share of persons of near-retirement age and an equal reduction in the share of people between the ages of forty and forty-nine. Current patterns of specialist employment and disemployment prevent the rejuvenation of the work force and will result in a failure to maintain the stability of the present age pattern.

Income Levels and Sources

- The level and structure of pay (in US dollars) received today is practically the same as in 1992, although the cost of living has risen considerably since then. About 60 percent of surveyed specialists receive monthly pay equivalent to less than US$50, and only 3 percent receive US$100 to US$125.
- Differentiation of pay by position held is minimal and to a relatively small degree depends on a city's primary activity.
- Average income per family member amounts to about US$46 and is nearly the same in all types of cities.
- Regular pay has ceased to be the main source of livelihood, giving way to money made by moonlighting. Sixty percent of specialists supplement their salaries by outside work. In most cases incomes earned through outside work are either comparable to or higher than regular pay. This explains why per capita incomes are higher in locations where the share of specialists doing outside work is greater (research and production centers) than in locations where regular pay is higher (chemical centers). In nearly two-thirds of all cases, money made on the side is earned outside a specialist's profession. The average monthly income of specialists who do outside work is US$74 as against US$43 earned by those who do not. The average pay that specialists working in closed cities regard as sufficient to ensure themselves of a reasonable subsistence is US$160 a month. This is four times greater than their regular pay and a little more than twice as much as earnings that include money made on the side.
- An upsurge in the number of specialists who were moonlighting began in 1989–1992, and spiked in 1993. A combination of increasingly deteriorating economic conditions at state enterprises and the development in closed cities of a locus for outside work—the private sector—led to this situation. In all, commercial activities rank first at the surveyed enterprises, followed by work done under foreign research grants and contracts, and then by work done under domestic research grants and contracts.

Living Standards of Specialists

- The vast majority of people at the enterprises are provided with housing. Nearly 90 percent of surveyed specialists live in separate apartments. To leave a closed city today means, in effect, to lose one's housing, for the opportunities to sell it are at best limited by a low effective demand, and, in addition, in most cases housing belongs to local enterprises. This circumstance is a major restraint on the outflow from closed cities.

- Between 4 percent and 15 percent of respondents in different types of cities believe that their financial situation has remained unchanged or has improved over the period of reforms (1992–1999). About 85 percent to 96 percent of respondents in the surveyed cities are of the opinion that their financial situation has deteriorated, and 41 percent to 61 percent note that it has deteriorated sharply. If stated in terms of "win" and "loss," then specialists working in closed cities are among those who have suffered losses during the reforms.
- Engineers and research workers, who account for four-fifths of the total number of specialists, give the most negative evaluation of their financial situation: between 83 percent and 88 percent regard it as difficult or very difficult, and only 1 percent to 2 percent as good. Heads of section are more optimistic: nearly three times as many of them regard their situation as normal, and four to five times fewer regard it as very difficult.

Attitudes toward Migration

- Fourteen percent of surveyed employees would like to work abroad. This number has fallen to between one-fifth and one-sixth of what it was in 1992. The drop is a result of the fact that low incomes and administrative restrictions make it virtually impossible for residents of closed cities to leave the country on their own.
- Eighty percent of surveyed experts would be willing to work in the military industry of a foreign country.
- Only 16 percent of respondents have a negative attitude toward those who are going to emigrate from Russia and therefore cannot be, in principle, regarded as potential emigrants. Nearly 60 percent are neutral (haven't given emigration much thought or view it as a personal affair) and 21 percent approve of them or even envy them. Therefore, emigration potential is much greater than appears from the answer to the question about specialists' intentions to work abroad.
- Emigration flow from closed cities started approximately in 1991 and reached its peak in 1996, following which it began to decrease. In the 1990s, about 1 percent of the total number of specialists working at the surveyed enterprises went abroad each year.

Moves to Private Enterprises

- It is not emigration but specialists' taking jobs with private businesses and launching their own businesses that pose the most serious damage to the enterprises by depleting their personnel. In the 1990s, the intensity of the outflow from enterprises to private businesses was five to six times greater than emigration. Specialists who quit their jobs at state enterprises are playing a major part in shaping the new economic entities. Forty percent of them are running their own businesses, and 60 percent are continuing to work for hire.

- Taking a job in private business entails a change of profession. Less than 25 percent of both men and women who have taken jobs with private businesses are working in the same profession as before. A total of 90 percent of those who have taken such jobs are satisfied with the fact that they have left state enterprises for their present position. People running their own businesses and those working for hire tend to be equally satisfied with their decision to quit the state enterprises. It is not by accident that more than 70 percent of those who would like to quit their jobs at the surveyed enterprises wish to take jobs in private business. Of every one hundred specialists who quit their jobs at state enterprises to take jobs with private businesses fewer than sixty return to public sector enterprises.

Education of New Specialists

- New employees at the enterprises entered graduate schools during the 1990s, a period of low acceptance standards and low competition for available slots.
- In the present economic situation, 75 percent of students are forced to take jobs while pursuing their studies. Outside work, however, adversely affects grade averages. Among students who did outside work, those who received mostly excellent grades numbered half those receiving mostly satisfactory grades and one and a half times fewer than those receiving mostly good grades. Students who received mostly excellent grades spent more time studying than making money on the side. By contrast, nearly half of those who received mostly satisfactory grades spent as much or more time on outside work than on studying.
- In all, 43 percent of surveyed graduates would not, under any circumstances, work at state enterprises, and this sentiment is growing. Approximately one-third of respondents would take such a position, but only if circumstances (especially salary levels) in the cities changed significantly.
- The better the student, the greater the probability he or she will take a job at a state enterprise. This holds out hope that state enterprises stand a better chance than commercial companies of recruiting specialists whose academic training is of high quality.
- The survey has shown that the most serious negative aspect of the changes in personnel consists of the aging of the work force in the absence of an inflow of young people to the enterprises.
- As for what the consequences of this aging trend will be, 50 percent of respondents cited a slowdown in scientific research, and 42 percent cited a paucity of new ideas coming from state enterprises. These are alarming symptoms, precursors of a situation in which the nuclear industry is slow to adapt to modern requirements.

Security Implications

- Forty percent of respondents believe that negative changes in personnel composition at their enterprises have already adversely affected the country's nuclear security, and 53 percent think such an effect will be felt in the near future. Only 6 percent of respondents believe that changes now taking place will not affect Russia's nuclear security.

MISSILE CITIES

Russia's missile complex is well-developed and has produced a wide range of civilian and military rockets. The skills of the specialists employed in these cities would be valuable for those states interested in developing long-range ballistic missile capabilities. Unlike the nuclear complex, the missile cities were never "closed," providing residents with greater access to the outside world and other employment opportunities. Three major missile enterprises were surveyed for this study, and the major findings are as follows:

Overall Migration

- Migrants have played a seminal role in providing specialist personnel for the missile industry. Their influence is greatest in Miass, where they account for 95 percent of currently employed specialists. In Votkinsk and Korolev, migrants make up 50 percent of all specialists.
- The number of migrants employed by the missile enterprises rose until the 1980s. Thereafter, the number of migrants has rapidly fallen, reflecting the general situation of creeping stagnation and degradation in the industry.
- The bulk of migrants (from 88 percent in Korolev to 49 percent in Votkinsk) are adult outsiders who deliberately decided to move to missile cities.
- Over the past ten years, the missile industry enterprises have been experiencing a reduction in employment.
- As the enterprises' demand for specialists nose-dived, there was a change in the hiring pattern in the 1990s in favor of local residents. This has radically reduced migration to the missile cities.
- In the 1990s, migrants came mostly from residential localities within the missile city regions.

Qualifications of Specialists

- Most holders of postgraduate degrees are migrants who moved to missile cities from beyond the regions where the cities are located. Those born outside Russia are the second largest group in this category of migrants.
- In the missile industry, those with the highest qualifications consist mostly of persons born around Russia's periphery, including ex-USSR Republics. Therefore, the 1990s' slump in migratory inflow of specialists to the missile enterprises actually diminished the overall quality of specialists in the missile cities.
- Educational institutions located in ex-USSR Republics, with a 1 percent to 2 percent share, play a very minor role in training missile industry specialists. The USSR's collapse has had no impact on the personnel training system for research and development establishments or manufacturing enterprises of the missile industry.
- Moscow's educational institutions play a significant role in the training of missile industry specialists in Korolev only. In Votkinsk and Miass, two-thirds of all specialists were educated either in the cities themselves or within the local regions.

- The composition of newly hired personnel at missile enterprises demonstrates a continuous replacement of migrants with permanent residents of missile cities who hold diplomas from institutions of higher learning located in the missile cities themselves. The missile industry, which in its prime used to extensively employ personnel from the entire country and used to rely on a broad network of colleges and universities, currently meets its modest demands for specialist personnel mostly by hiring graduates of local colleges and universities who reside in the missile city regions.

Age of Specialists

- Thus, in the 1990s, the economic crisis and dramatic reduction in missile industry employment helped normalize the specialists' age profile. Forced to retrench, the enterprises fired older employees first, while hiring mostly young people. But for the need to retrench, the continuation of negative trends in personnel mix seen in the early 1990s would have meant that an overwhelming share of specialists would be of preretirement and postretirement ages. Such a development could have crippled the industry.

Income Levels and Sources

- In Votkinsk, 80 percent of all specialists have monthly wages in the range of US$25 to US$50 per month; 50 percent of Miass specialists earn incomes that fall in that range. The average monthly wage levels in Votkinsk and Miass amount to US$40 and US$50, respectively. In Korolev, 40 percent of all specialists make between US$100 and US$150, while 35 percent make between US$50 and US$100 per month. The average monthly wage in Korolev is US$115.
- In Miass, wage delays average six months virtually across all specialists. In Votkinsk, 50 percent of specialists are owed back wages, and the delay in payment of wages is under one month. Korolev experiences no wage delays.
- Average wages that, according to specialists themselves, would be commensurate with their occupation and qualifications are as follows: in Votkinsk and Miass, US$170 and US$225, respectively; in Korolev, US$420. These figures are about four times as high as actual wages in these cities.
- In fact, the salaries that specialists consider presently commensurate with their occupation and qualifications are unrelated to occupation and qualifications; rather, the desired salary levels depend on the enterprises' economic situation and actual wage levels.
- Average monthly income of the specialists' families is low and strongly differentiated across various cities. In Miass and Votkinsk, it equals about US$33, while it is about US$80 in Korolev. Average amounts of desired family income per capita are three to four times higher: US$214 in Korolev, and US$123 and US$110 in Miass and Votkinsk, respectively.

Living Standards of Specialists

- Over 80 percent of specialists live in individual apartments. There is no difference in housing standards between missile cities located in outlying regions (Miass and Votkinsk) and those immediately outside Moscow (Korolev).
- In order to supplement their low salaries, specialists have to hold second jobs. Overall, 28 percent of specialists in the surveyed cities moonlight.

- Most specialists began moonlighting between 1990 and 1997. This development was driven both by the progressively worsening economic positions of government enterprises and by an expanding base of moonlighting jobs, that is, the sector of the economy not related to government enterprises expanded in the missile cities.
- Forty percent of moonlighters in Miass have incomes from their second jobs comparable to their regular wage; the rest claim lower moonlighting incomes. In Korolev, about 70 percent of all moonlighters have earnings from their second jobs that are either comparable to their regular wage or twice as high. The most difficult situation prevails in Votkinsk, where the overwhelming majority of moonlighters make only 30 percent to 70 percent of the lowest wage among the cities surveyed.
- Missile city specialists have lost out in the reforms. A large majority (66 percent to 86 percent) find themselves worse off financially; this figure includes 48 percent in Korolev, 72 percent in Miass, and 79 percent in Votkinsk of respondents who saw a dramatic fall in living standards.
- None of the respondents consider their current financial situation to be very good. Virtually no one refers to it as being good. Only between 8 percent and 21 percent view it as normal, whereas the rest mostly consider it difficult or desperate.

Attitudes toward Migration

- The percentages of persons willing to work abroad varies from 12 percent at the strategic missile plant in Votkinsk to 28 percent and 32 percent in Korolev and Miass, respectively.
- Between 1992 and 1999, the number of people who wanted to work abroad fell by a factor of 2.5. Those willing to emigrate in 1999 have virtually the same age distribution as in 1992, only their desire is presently 2.5 times less intense.
- Only one person in five who is willing to emigrate does something to realize that desire. Only 5 percent of those wishing to work abroad (that is, 2 percent of persons presently employed) take any concrete action by approaching foreign companies. Generally speaking, most persons willing to emigrate "merely dream" about it.
- Therefore, emigrating independently from missile cities in order to work abroad is presently next to impossible. People are not ready to take independent action. Their emigration must be properly arranged. Thus, in principle, emigration from missile cities may occur only through an arrangement established by someone other than the person wanting to emigrate, not through individual efforts.
- Less than one-half of respondents said no in reply to the question whether they would work in the military industry of another nation. One person in five would agree to do that kind of work, while the rest are either undecided or gave a qualified response.
- Specialists do not consistently reject working in countries normally referred to as aggressive regimes. Sixty percent of them failed to mention at least one such country among those to which they would refuse to go.
- Only 16 percent of respondents have negative views of people who leave Russia and therefore may not be regarded as potential emigrants. Almost 40 percent are indifferent, having never given emigration much thought or viewing it as a personal matter, and an equal number approve of emigrants or even envy them. Therefore, emigration potential is much higher than the answers regarding intentions to work abroad might suggest.

- Eighteen percent of respondents at the surveyed enterprises indicate that some of their former coworkers have gone abroad since working at the enterprise. This figure is highest in Miass, at 21 percent, and lowest in Votkinsk, at 8 percent.
- Emigration started in 1967, peaked in 1997, and began to decline thereafter. Over the period in question, emigration averaged about 1 percent of all specialists employed by the enterprises surveyed.
- Eighty percent of those who emigrate are men. Of these, 60 percent are ethnic Russian, and the rest are mostly Jewish.
- Economic considerations are the main reason for emigration. One person in three left for family reasons, while one in five had political motives.
- Specialists from missile cities have no history as yet of going to countries with aggressive regimes. Forty-three percent of all emigrants went to North America, 15 percent to Israel, one person in three to Western Europe, and the rest to Australia and New Zealand. Four-fifths of all emigrants left for good; the rest went abroad to work temporarily.

Moves to Private Enterprises

- Emigration is not the worst problem to hit the enterprises' human resources. Migration of specialists to private business and to self-employment has been even more detrimental to the pool of specialists available. The ratio of emigrants to those moving to private businesses and self-employment is 1:6.
- Specialists leaving missile enterprises play an important role in the development of new economic structures. Thus 48 percent to 53 percent of these specialists have their own business, while the rest remain hired employees, though now in the private, as opposed to the public, sector.
- As a rule, migration to a business entity involves a change of profession. Only 6 percent to 24 percent of persons taking business jobs have the same profession they had at the public enterprise. The rest have had to change their trade. Professional change does not deter specialists from joining business entities, however. Ninety percent of specialists who have joined business entities are happy to have left the government enterprise.

Education of New Specialists

- Most young specialists who will become employed in missile cities in the next few years were admitted to college and university at a time of low competition for admittance—two to three persons per vacancy or even less. A low competition rate translates into low admittance standards for newly admitted students and consequently into a generally poor quality of graduate.
- Over half of all students chose their occupation deliberately, in the belief that it is an interesting field. The share of students selecting their occupation randomly has fallen. Simultaneously, in another development, there is a rise in the share of students attaching a higher importance to advanced education for its own sake, rather than for its value in preparing one for a specific occupation.
- Deliberate occupational choices are closely related to the academic achievements of would-be specialists. Respondents with an excellent academic record include only students who, on admittance, believed the chosen occupation to be promising.

- In principle, compared to private businesses, government enterprises have a better chance of hiring mostly B and A students over average ones. It is important that government enterprises not miss this chance while it exists.
- Research findings show that, according to respondents, major adverse developments affecting the human resource profile include an aging work force (61 percent), and an inadequate inflow of young workers to missile enterprises (48 percent).
- For the most part, the reasons for the aging of the work force are unrelated to the natural generational change, which has seen older workers retire while fewer younger workers replace them. It is primarily caused by an inadequate inflow of young workers. The latter is due to an ongoing decline in the levels of employment at missile enterprises.
- Missile enterprise employment has fallen not only because of pre-planned retrenchments, but also because promising specialists have left to join private enterprises. The share of specialists in the most productive age bracket, thirty to forty years, among those moving to business entities is almost four times higher than any other age group among all employees. Specialists under thirty are half as likely as those between thirty and forty to leave for jobs in private business.
- The few young workers hired by missile enterprises have poor engineering training. On the other hand, there are no incentives—for example, work involving creative self-development, career prospects, or adequate wages—for well-trained young specialists to join.
- Among the adverse developments affecting the employee composition at missile enterprises, 37 percent of respondents cite a slowdown in scientific research, while 62 percent mention a dearth of new ideas and overreliance on earlier research and development projects.

Security Implications

- Forty-one percent of respondents believe that adverse developments in the makeup of specialist personnel have already affected nuclear security, while 42 percent expect such negative consequences in the near term or longer term. One in four is either undecided or believes that current changes will not affect Russia's nuclear security.
- Most respondents (81 percent) believe that the situation in missile cities, because it affects the country's defense, endangers Russia. Only 10 percent of respondents refer to a global threat in terms of missile technology proliferation.