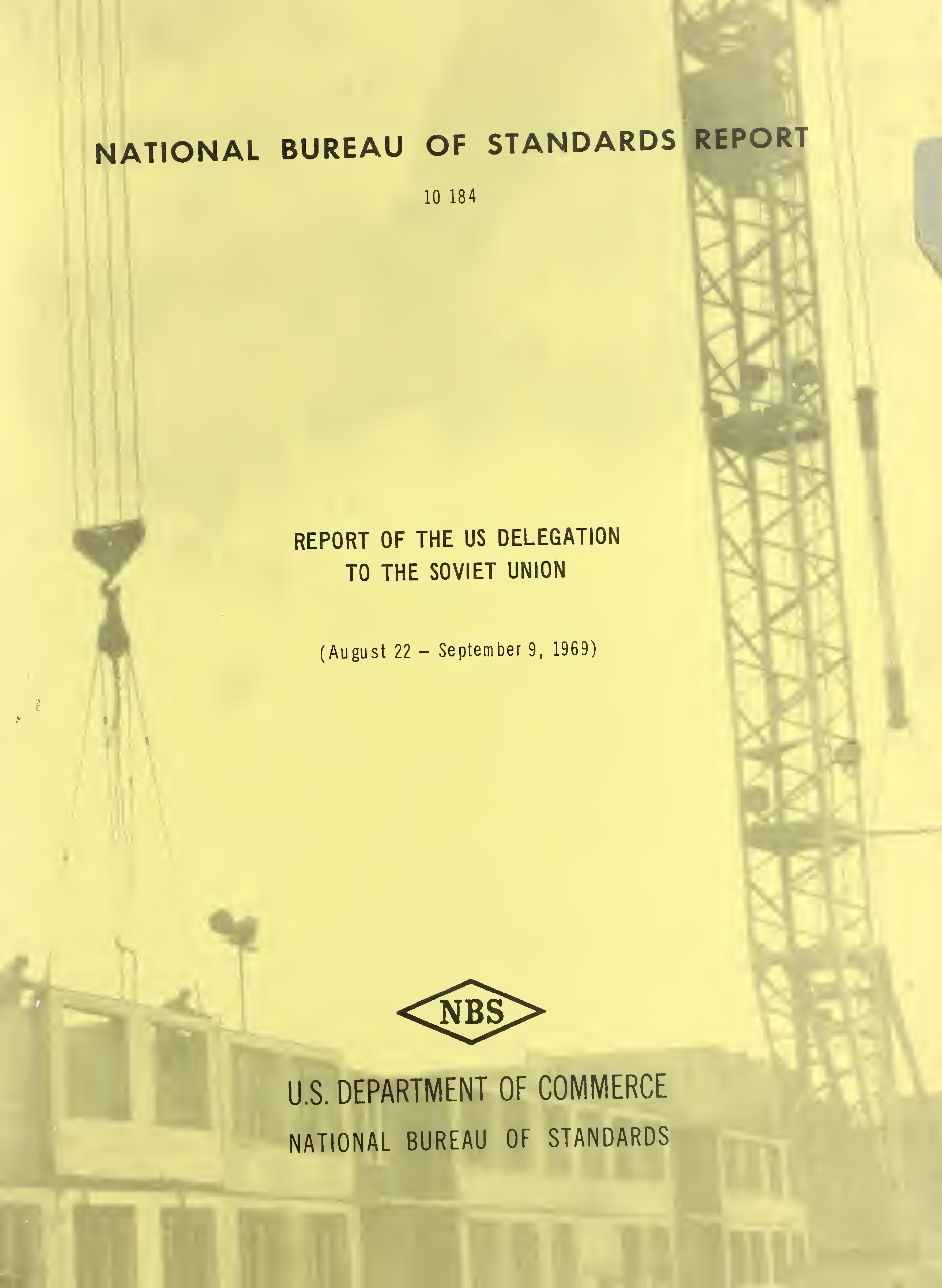

NATIONAL BUREAU OF STANDARDS REPORT

10 184

REPORT OF THE US DELEGATION TO THE SOVIET UNION

(August 22 – September 9, 1969)

NBS

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		**NBS REPORT**
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James R. Wright, Chairman

IMPORTANT NOTICE

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Approved for public release by the director of the National Institute of Standards and Technology (NIST) on October 9, 2015

NBS

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

foreword

This document reports on a US delegation's firsthand examination of the building industry in the Soviet Union, including Soviet planning, design and construction practices.

Representative of a wide range of US building industry sectors, the delegates, who numbered eight, traveled to the Soviet Union under the 1968-69 US/USSR Exchanges Agreement. The information and impressions each gathered during the August 23 - September 9, 1969, tour are contained herein in the form of individual reports.

The Exchanges Agreement prescribed that emphasis be placed on "industrialization of the building process." The American sponsor of the exchange, the Building Research Division of the National Bureau of Standards, US Department of Commerce, was particularly interested in Soviet procedures and methods for evaluating innovations in building construction - an interest shared by the delegation members. The preeminence of the USSR in the industrialization of the building process was readily acknowledged, but little was known about the formal procedures for evaluating new building designs and products in the USSR.

Because trends in the United States are toward greater use of industrialized building techniques, the US delegation was most eager to learn of the Soviet experience with industrialized concepts and methods.

Accordingly, the itinerary for the Americans, while structured to provide a general overview of Russian planning, design and construction practices, was arranged primarily to yield an understanding of the industrialized procedures employed by the Soviets in meeting shelter pressures greater than those felt to date in the US.

The delegation took to the USSR a set of pre-identified questions and, to a considerable extent, the delegates' reports are based on Soviet responses to these questions. But once inside the Soviet Union - and owing to the vast difference between the US and Soviet systems - the irrelevance of some of the questions became apparent. Inquiries concerning the Soviet mobile home industry, for example, were rendered academic by the fact that no such industry exists in the USSR. Additionally, some questions were not answered or not answered fully. However, if the reader is interested in the nature of the questions, he can refer to the question set in this document's Appendix.

The Exchange Agreement also provided for a tour of the US building industry by a Soviet delegation. This was made September 29 to October 16, 1969. The names of the members of the Soviet Delegation are included with an itinerary of the tour in the Appendix of this document.

Neil Gallagher
and Barbara Steele,
Report Editors.

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delegation/itinerary

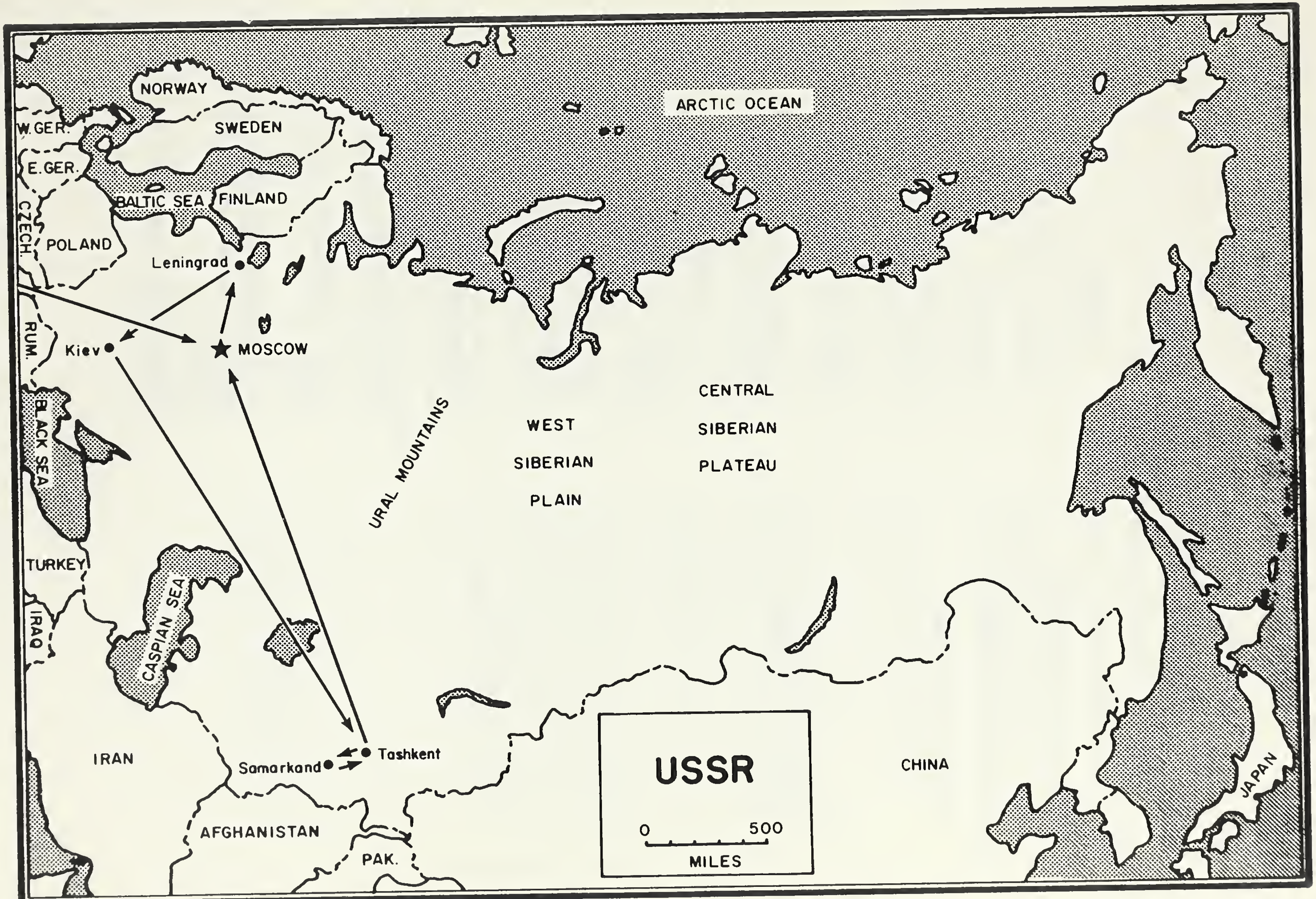
The experience backgrounds of the eight members of the US delegation include general contracting, architecture, building systems, building standards, building materials, urban technology, building research management, industrial engineering, mechanical systems and human factors.

The delegates and their organizations and titles are listed on the following page along with the area of tour responsibility assigned to each.

Also following are a map showing the travel route of the delegates which is followed in turn by the tour's itinerary/agenda.

MEMBERS OF THE US DELEGATION

DELEGATE	ORGANIZATION	POSITION	AREAS OF RESPONSIBILITY
Dr. James R. Wright (Chairman)	National Bureau of Standards Department of Commerce Washington, D.C.	Chief, Building Research Division, Institute for Applied Technology	building research management; organic building materials; building standards
David Watstein (Interpreter)	Structural Clay Products Institute McLean, Virginia	Manager, Structural Research	masonry and clay tile; reinforced concrete; structural engineering
W. Burr Bennett, Jr.	Prestressed Concrete Inst. Chicago, Illinois	Executive Director	cement and concrete; modular coordination; building systems
Philip D. Bush	Kaiser Engineers Oakland, California	Vice President	industrial engineering; metallic building materials; industrialized building (housing)
William W. Caudill	Caudill, Rowlett, Scott Houston, Texas	Principal (Partner)	architecture; design; computers; building systems
Charles C. Law, Jr.	Public Buildings Service General Services Admin. Washington, D.C.	Chief, Technical Services Branch, Design Services Div., Off. of Design and Construction	mechanical engineering; mechanical systems (heating, air conditioning, plumbing); acoustics
Fred W. Mast	Jens Olesen & Sons Construction Co. Waterloo, Iowa	President (immediate Past President of the Associated General Contractors of America)	general contracting
Dr. Charles J. Orlebeke	Department of Housing and Urban Development Washington, D.C.	Executive Assistant to Secretary Romney	urban building technology; human factors; labor


USSR
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MILES
ARCTIC OCEAN
NORWAY
SWEDEN
FINLAND
W. GER.
E. GER.
BALTIC SEA
POLAND
CZECH.
RUM.
BLACK SEA
TURKEY
IRAQ
IRAN
CASPIAN SEA
AFGHANISTAN
PAK.
Leningrad
MOSCOW
Kiev
Tashkent
Samarkand
URAL MOUNTAINS
WEST
SIBERIAN
PLAIN
CENTRAL
SIBERIAN
PLATEAU
CHINA
JAPAN

ITINERARY

- MOSCOW -

Date	Agenda
August 23, Saturday	Evening arrival in Moscow Meeting at the airport
August 24, Sunday	Sightseeing
August 25, Monday	Discussion at the Gosstroy of the U.S.S.R. Clarification of the program
	Visit to Gosgrazhdanstroy (Public Buildings Construction)
August 26, Tuesday	Discussions at Glavmosstroy (Moscow Municipal Construction)
	Visit to Lenin Mausoleum
	Visit to new public building sites
	Discussions at Tzniepzhilishcha (Central Research Institute for Economic Planning of Housing Construction)
August 27, Wednesday	Discussion at Glavmosprom-stroymaterial (Moscow Directorate of Structural Materials Industries)
	Visit to Precast R.C. Units Plant No.9 (D.S.K. No.9)
	Visit to Architectural Millwork Plant
	Visit to Permanent Building Material and Building Elements Exhibit
	Departure for Leningrad by train "Red Arrow"

August 28, Thursday	Arrival in Leningrad Discussions at Glavleningrad-stroy (Directorate, Leningrad Municipal Construction) Visit to construction sites Discussions at Glavzapstroy (Directorate, North West Construction, includes Lenin-grad, Novgorod and Pskov regions)
August 29, Friday	Visit to D.S.K. No.2 (Housing Construction Combine No.2) and Automated Dispatching Service Discussion of design of stand-ardized buildings at Lenzniiep (Leningrad Central Research Institute for Economic Planning)
August 30, Saturday	Sightseeing. Visit to Petrodvoretz (Peter's Place) Hermitage
August 31, Sunday	Sightseeing. Visit to Pushkin (Katherine's Palace) and Pavlovsk (Paul's Palace) Luncheon with Palace guides in staff dining room Departure for Kiev by air

- <u>KIEV</u> -

August 31, Sunday	Arrival in Kiev Meeting with Ukrainian hosts in Borispol' Airport waiting room to confirm program

September 1, Monday	Discussion at Ukrainian Gosstroy led by Chairman of Gosstroy, M. I. Burka on problems of planning, design and organization of construction
	Visit of Glavkievgorstroy (Kiev Municipal Construction)
	Visit to D.S.K. No.3 (Building Construction Combine No.3) Inspection of plant and automatic dispatching service.
	Visit to Plant Construction Combine of Ministry of Industrial Construction at Brovary (Brewer-town)
	Inspection of Russanov Housing Complex (construction in progress)
September 2, Tuesday	Visit to Construction and Building Erecting Trust No.1, Ministry of Industrial Construction Ukr. SSR
	Inspection of Diamond Plant and garage for 1200 cars
	Visit of Collective Farm "Kodaki" and inspection of its construction
	Visit to Pioneers' Children's Palace, and sightseeing
September 3, Wednesday	Discussion at NIIASS (Science Research Institute for Automated Systems of Planning and Construction Management Ukr. Gosstroy)
	Insepction of Experimental 3-D Block Construction (room size blocks)
	Visit to St. Sophia's Cathedral XIth Century)

September 3, (continued)	Visit to Kiev Cave Monastery and Kiev City Park. Visit to Golden Gate (10th century entrance to city of Kiev) Dinner and reception honoring the U.S. Delegation by Gosstroy of Ukr. SSR Departure for Kiev Airport (Borispol') for flight to Tashkent

- <u>TASHKENT</u> -

September 4, Thursday	Arrival in Tashkent Meeting with hosts in Tashkent Discussion of industrialization of housing and public building construction, Gosstroy of Uzbek SSR (Uzbekistan) Visit to GlavAPU (Chief Architect's Office) and Tashguiprogor Institute (Tashkent Institute for Design of City); discussion with Chief City Architect of planning and construction problems and their solutions for housing and public buildings construction in Tashkent. Inspection of new residential construction
September 5, Friday	Discussion at Glavtashkentstroy (Directorate, Tashkent Municipal Construction) of application of large precast panels and panel frame construction in Tashkent Visit to Tashkent D.S.K. No.1

September 5, (continued)	Inspection of new construction designed for severe local seismic conditions
	Visit to Uzbek Khanza Theater to view play based on life of Uzbek national hero Ulugbek
September 6, Saturday	Departure for airport for flight to Samarkand
	Entire day spent in Samarkand viewing historical and architectural monuments of the city
	Departure for airport and return flight to Tashkent
	Arrival in Tashkent
September 7, Sunday	Farewell breakfast with hosts in city of Tashkent
	Departure for airport and flight to Moscow

- MOSCOW -

September 7, Sunday	Arrival in Moscow
	Attend performance at Bolshoi Theater (opera - Marriage of Figaro)
September 8, Monday	Visit to NIIZhB and NIISK (Institutes for Concrete and Reinforced Concrete and for Building Constructions). The latter Institute includes the Soviet Masonry Research Laboratory

September 8, (continued)	Final visit and discussion with hosts at Gosstroy of USSR Reception and dinner honoring US Delegation by Gosstroy of USSR at Moscow suburban resort, "Beryozki."
September 9, Tuesday	Exit interview at US Embassy with Charge d'Affairs Depart for Moscow airport (Sheremetyevo) and flight to Paris

delegates' reports

BENNETT

REPORT

Mr. W. Burr Bennett, Jr.

Executive Director
Prestressed Concrete Institute
Chicago, Illinois

FIRE SAFETY AND CODES

Despite continued questioning in several cities, little was obtained concerning the details of fire resistant requirements in the USSR. A copy of the standard was requested and promised by Gosstroy but not received to date.

Apparently reliance is placed on prototype structure tests rather than on controlled laboratory research with components. We were told that a full-scale 12-story building burnout test was held to determine the adequacies of panel construction. The same type of testing was done in conjunction with the development of the three-dimensional precast boxes. Fire resistance ratings are apparently based upon a maximum ambient temperature of 800°C (1472°F).

Statistics on fires in Russia were not available from construction or engineering organizations visited. In effect, it was stated that fire was not a problem with the exception of some gas explosions in housing. One institute is devoted to fire studies. The work there apparently is limited to rational design for fire resistance rather than performance testing as is common in North America.

There are the usual building regulations concerning occupancy requirements in public gathering places, fire-proofing of theatre curtains, etc. In summary, however, it appears that less concern exists in the USSR than in the United States with regard to fire.

- Code Writing

Building codes are written in the Institute for Reinforced Concrete Research and the Institute for Structural Design located at the same site in Moscow. Provisions are prepared at the Institute which has the authority to request reviews by selected specialists throughout the country. Once the provisions are prepared they are submitted to Gosstroy for approval. When approved, they become law. The origin of requests for building code provisions can come from Gosstroy or may be generated within the Institute.

SYSTEMS BUILDING

Essentially the Soviet approach to building is a systems concept. The design of both housing and industrial buildings is based on a set of coordinated modular dimensions; integration of some services is accomplished and the production of components is highly industrialized. The subject of performance specifications was discussed in some detail and the general impression obtained was that in the planning for buildings, performance concepts are considered to some degree. Improvements on existing designs are based on interviews with users; orally and through questionnaires.

• Computer's Role

Computers play a role in the construction field primarily as a device to control the flow of materials and components to the job site. A combine (prefabricated concrete producer) may handle so many projects scattered throughout a city that control of the building process is too complex for ordinary methods. Computers are also used for special design problems such as dynamic analysis for seismic loadings. Little use of the computer is made for cost control purposes. Since schedules did not permit visits to computer centers, this information was gathered during the usual question and answer sessions.

MODULAR COORDINATION

The design of industrial buildings is on a well-defined modular layout with multistory column centers at 6 x 6, 6 x 9, 6 x 12, or 7 1/2 x 9 meter grids. In general, the preferred grid is 6 x 6, increased in either direction by multiples of 30 centimeters.

For one-story industrial buildings utilizing prestressed concrete trusses for the main roof members, columns are on 12 meter spacing with trusses at 18, 24 and 36 meter spans. The trusses are covered with 3 x 12 meter precast ribbed slabs. Components are placed on center lines of the modular grid. This works well except at corners when combining prefabricated concrete with brick construction.

For housing, the modular scheme is more closely interrelated and the same module is used for vertical and horizontal coordination. The series are based on 3 M increments with M equal to 10 cm. Preferred dimensions are 240, 300, 360, 480, 600 and 720 cm. For public buildings the module is 60 M or 30 M with a permitted but not preferred series based on 15 M.

In general, the USSR is using modular grids for layout purposes. The work coordinates well with ANSI Committee A62 standards but may not be as detailed as A62 which presents both planning modules and a series of interrelated component dimensions.

The scheme used is especially effective for industrial buildings since it permits standardization of prefabricated columns, trusses, roof slabs and wall panel components. The spans and column spacings are large enough to permit flexibility of plant layout. The modular coordination methods work equally well in housing but with the limited number of standard housing designs, the value of modular coordination is not quite as apparent as for the more open industrial building systems.

We saw little or no integration of building subsystems except the burying of electric wire in the precast slabs during manufacture. In one factory, we also saw radiant heat piping assemblies connected to the reinforcing cages. In most cases, supply wiring and piping is hung on the outside of wall panels.

SAFETY STATISTICS

Each precast concrete combine has a small department responsible for safety. Usually one engineer from the department is assigned to safety at the jobsite and one or more to factory production safety. Statistics on safety were not made available and accident rates apparently are not considered significant. First aid facilities are available at the plant. There appears to be a total lack of the use of safety headgear and safety shoes although equipment seems to be reasonably well guarded. In view of the avowed shortage of labor in the Soviet Union, this apparent lack of emphasis on safety seems inconsistent.

PRECAST AND PRESTRESSED CONCRETE

Precast concrete is the preferred building material and is used extensively for many types of buildings. For short span members such as housing slabs, precast reinforced concrete is used; for longer spans prestressing is incorporated. Of the precast concrete produced, approximately 60% is reinforced concrete and 40% is prestressed concrete.

Although the figures quoted by the various agencies visited vary somewhat, it appears that in the large cities, where it is convenient to build high capacity factories, some 70% of the construction is precast concrete and the remainder brick. For the entire country, precast concrete is used for 30% of all structures with brick for the remainder. Some steel structures are built but the use of steel appears quite infrequent. In one of the research institutes, studies are underway concerning welding of structural elements, so there may be more steel construction planned for the future. The stated goals on use of materials is to achieve a level where 80% of the construction will be in precast concrete. The reason for this concrete preference is based on evaluation of the following major factors:

1. Labor: There is a shortage of available labor. Estimates provided range from 25% to 30% more labor needed. In view of the more efficient use of labor under factory environment, it is natural to plan as much factory production as possible.

2. Quality Control: The difference in quality of

finish work done at the jobsite versus that done at the factory underscores the desire to include as much of the finishing operation as possible in the factory.

3. Economics: Soviet studies indicate a first-cost savings of 6% to 12% over brick.

4. Speed of Construction: The delegation was told that prefabricated concrete construction can be built with a 45% savings in time.

• Boxes

The evaluation of the above four factors has led to the widespread use of precast concrete. This viewpoint is reflected in the latest decision to extend the manufacture of room-sized box units. Twenty-seven factories are planned to produce boxes across the country. One of the major reasons for this latest decision is that 75% to 80% of the finishing can be accomplished at the factory. This reduces site labor needs and increases quality. The units will be used in 5 to 9-story structures. They anticipate a box size of 5 x 8 meters weighing about 25 tons. They are also considering a 2.6 x 11 meter unit. Presumably lightweight aggregate concrete will be used in the manufacture of boxes to reduce weight.

• Panels

Loadbearing wall panel buildings are very popular and are used for structures up to 25 stories in height. In general, buildings are 5, 9, 12, 16 or 25 stories in height with elevator service for buildings over 5 stories. Both precast and cast-in-place reinforced concrete frame structures are used in seismic areas in addition to the loadbearing panel buildings. We saw several precast frame buildings in the 9 to 12-story range.

• Catalog

The Soviets have developed a catalog of products useful for up to 12-story buildings and including public buildings of all types. Planning is underway for a universal building suitable for a dwelling, hospital, hotel, etc. Also in the planning stage are standard buildings for educational purposes.

• Precast Concrete Plants

Plants producing precast concrete are highly mechanized, large-capacity factories. Plants having a capacity of 200,000 cubic yards of concrete products per year are commonplace. Most of these high-capacity plants produce panels in the following several ways:

1. A highly developed continuous conveyor system with panels moving under a casting position; this was labeled an experimental plant, but it was producing panels at a production rate.

2. Heavy steel pallet systems used with the forms constructed one to a pallet. The pallets move on wheels on a semi-automatic belt concept.

3. Pallets were also used in a fixed casting position and then transported by overhead crane to the curing operation.

4. Panels were also cast at fixed positions with the concrete delivered in buggies pulled by small tractors. The buggies then lifted above the panel by overhead cranes for discharge into the forms. In these cases curing was

achieved by electrical radiant heat units mounted in a hood that is placed over the finished panel after the concrete is finished. The hood completely covers the panel. Temperature of the concrete is controlled automatically.

5. Panels were also cast in vertical battery molds in what appears to be a highly efficient operation. One plant we visited contained 30 battery molds each with about a 12 panel capacity.

The surface quality of floor and wall panels appears adequate. Floor panels usually have surfaces suitable for painting on the underside and for direct application of tile or carpet on the exposed side. The surface quality of the battery mold panels is excellent.

Curing is largely accomplished by steam at atmospheric pressure; some radiant electrical heating is used as mentioned previously. In the steam curing process there appear to be four main approaches: (1) Steam tunnels beneath the casting bed. When the pallets reached the end of the casting and finishing operations they were lowered by scissors jacks to the steam tunnel elevation traveling beneath the casting bed with removal at the other end. (2) In the case of the true conveyor system, the steam tunnel was in line with the casting and finishing operation. In this case the panel leaves the conveyor system by sliding on to a track with a section which can be tilted to a vertical position as the panel is lifted away for transport to the storage area. (3) One plant has a vertical steam chamber where pallets are moved vertically in the chamber to control the rate of rise of concrete temperature. Temperature in the chamber increases with approximate uniformity from the bottom to the top. (4) The last method we witnessed for steam curing was the introduction of steam into hollow forms both in vertical molds and for intricate products such as trusses which are cast horizontally.

Cycles for panel production, including steam curing, range from 6 1/2 to 8 hours. With electrical radiant heating under a hood, the curing cycle is reduced to 2 1/2 to 3 hours, this permits two cycles per shift.

The plants producing products for industrial buildings are not as highly mechanized as are the panel plants. Trusses are made by precasting the diagonal struts of the truss. These are then placed in the forms and cast into the compression and tensile chords of the truss with interlocking reinforcement. The tensile flanges of trusses are pretensioned with a large number of small diameter deformed wires. Prestressing steel has a light copper cladding which is applied during manufacture of the steel to prevent corrosion of the steel while in transit or storage.

To meet the spacing of columns for trusses in industrial buildings, 12-meter wall panels are prestressed. In some cases sandwhich panels are used with blocks of insulating plastic foam forming the center layer.

The industrial building component factories also produce piling. Below 12 meters in length, precast reinforced concrete is used for piling; above 12 meters in length, it is customary to use prestressed concrete piling.

Design procedures appear to be comparable to those used in the United States. Although insufficient time was available to permit detailed discussions, it was established that ultimate strength design methods are used; redistribution of moment is permitted and partial prestressing is an approved device. Concrete strengths are between 4800 psi and 6000 psi with higher concrete strengths achieved when needed. Concrete mix quality appeared to be excellent and where high strength Haydite concrete was used, a richer mortar layer was used on panel faces to obtain a tighter, more durable surface.

SEISMIC DESIGN

The Tashkent area is in seismic zone 9 which is apparently equivalent to our zone 3 (we were told that the USSR scale corresponds to the Mercalli scale of earthquake intensity). It was stated that design for the Tashkent area requires 100% more reinforcement than for non-seismic areas. The research institute in Moscow which studies seismic loading has a laboratory where 1/6 to 1/8 scale buildings are constructed on a platform which can be accelerated horizontally in two directions. A research institute in the Uzbek Republic is also concentrating on seismic problems but we did not have the opportunity to visit that institute.

A seismic test is planned near Tashkent for 1970. Full-scale brick and panel buildings will be constructed. One hundred and thirty meters away at a depth of 75 meters, 2000 tons of T.N.T. will be set off to simulate an actual earthquake. An atomic blast was considered but the idea was discarded because of the potential danger of subsoil water contamination.

It was stated that there are no height limits to buildings in seismic code provisions. Also it was stated that the preferred structural scheme for seismic areas was a concrete frame with non-loadbearing walls. The delegation visited a project of this type with cast-in-place frames which also made some use of a lightweight panel faced with asbestos cement covering a fiberglass core. We also saw a precast frame with gypsum partitions. However, by far the preponderance of structures was built of loadbearing wall panels with cast-in-place connections combined with short cast-in-place wall segments.

One of the peculiarities of the 1966 Tashkent Earthquake was the strong vertical accelerations caused by the location of the epicenter within the city proper. During the earthquake the two 9-story buildings then in Tashkent behaved very well. As a result, no design changes were made in details but it was decided to increase the loading from seismic degree 8 to degree 9.

ACOUSTICS

Although inquiries were made concerning details of acoustic requirements and test methods, details were not obtained, probably because we did not confer with the experts in this field. It was stated that the acoustic requirements are related to curves based on the wavelength of the type of noise anticipated. They also have norms for impact noise reduction. Unless the delegation receives written material on this topic, no more information is available.

BUSH

PART I

PART II

PART III

REPORT

Mr. Philip D. Bush

Vice President
Kaiser Engineers
Oakland, California

PART I

THE PLANNING AND DESIGN PROCESS

• The State Level

Almost all of the industrial construction and the bulk of the housing throughout the Soviet Union is owned by the State (USSR). Agencies of the State continue to account for most of the buildings constructed, although some private individuals and cooperatives are also permitted to build and own residential structures. The actual management of State-owned buildings is entrusted to local agencies, principally the municipal authorities; but in some cases, the industrial enterprise or another governmental establishment may own the building. In all cases, the State owns the land.

The State Planning Committee determines the capital required to be invested in new construction, and the State Building Committee (Gosstroy) approves projects and authorizes the allocation of building materials to the various ministries and construction sites. Gosstroy is the principal agency responsible for the technical aspects of construction for the USSR; it develops new designs, sets norms (standards), approves projects and building procedures, and arranges cooperative exchanges with the USSR republics, as well as with other nations. It has some 54,000 people, including 8,000 scientists, 34,000 technical people and 10,000 workers in experimental plants. Most of the individual republics and the major cities (Moscow, Leningrad, Kiev, Tashkent) have a republic or city Gosstroy with a total of another 180,000 people. The republic and city Gosstroys do their own design, regional planning and zoning, which are subject to approval by the USSR Gosstroy.

There are more than seven million people throughout the USSR involved in building and building materials. Total construction in the USSR is 30 billion rubles ($33 billion) per year. The USSR Gosstroy has nine divisions as follows:

1. Transportation - involved in building for railroads, subways, airports, ports and highways.

2. Special and Assembly - involved in construction of industrial pipelines and mechanical equipment.

3. Heavy Industries - involved in construction for the metallurgical industries.

4. Industrial - involved in construction for the chemical and oil industries.

5. General - involved in construction for the machinery and food industries.

6. Agricultural - involved in construction for rural area farms and housing for farmers.

7. Building Materials - involved in construction for the cement, asbestos, tile, glass, polymer, gypsum and brick industries.

8. Energy and Electrification - involved in construction of dams, gas lines and transmission lines.

9. Drainage and Water Supply - involved in construction of canals, dikes and water pipelines.

USSR Gosstroy approves a project but the industry itself must get its own financing from the State Construction Bank. Gosstroy determines what materials, machines, etc., will be necessary to carry out the USSR five-year plan and advises the production ministries so that they, in turn, will build the capacity to meet the plan.

This action also means approval of the expenditure of money and the allocation of materials in a definite time schedule. The exact location of any given industrial installation in or around a city would be the responsibility of the republic and the individual city planning agencies.

Within USSR Gosstroy, there is a State Committee for Civil Construction and Architecture, (Gosgrazhdanstroy) which is concerned with the technical aspects of housing and factory (light industry) construction. USSR Gosstroy sets the codes after it receives suggestions from its Research Institute for Concrete and Reinforced Concrete. The Institute can make provisional codes without Gosstroy approval.

- The Republic Level

At the Republic level, a typical organization is that of the Ukraine Republic Gosstroy which reports to both the administration of the Republic as well as the USSR Council of Ministers in Moscow. It has its own technical institute for such things as automation and mechanical research. The principal divisions within the Ukraine Gosstroy are:

1. Rural Construction

2. Metallurgical and Heavy Industry

3. Industrial Construction

4. Special Construction (electrical, mechanical subcontractors)

The Gosstroy is also responsible for regional, city and site planning in the Ukraine Republic, and for constructing some 500,000 apartments per year in the Republic, including 22,000 in Kiev alone. There are 30,000 designers in the Civil Construction and Architectural Division of Ukraine Gosstroy. Code problems peculiar to the Ukraine are settled by the Ukraine Gosstroy; others must go to the USSR Gosstroy for decision.

The Gosstroy of each republic is responsible for preparing the standard plans and designs for an apartment building and complex. These plans are handed to the city ministries which, in turn, deal with the "combines" - the firms that fabricate any structural items (such as concrete panels) and erect the buildings. No changes can be made to the plans and each Combine will use a given set of plans over and over. This, of course, helps economize on costs unless there are inefficiencies or substandard materials incorporated in the plans. In the latter case, hundreds of apartment units could be built before changes are effected.

• The City Level

At the city level, a typical Gosstroy organization is that of Glavleningradstroy which has 60,000 people and reports to the Leningrad City Council. It does the regional planning for the area (including a large region to the north), and reviews the City Council's master planning for the city proper. The local Civil Engineering Institute does all scientific work leading to the apartment building construction drawings which are prepared by Glavleningradstroy. For an apartment building, it is claimed that the time from concept to design is 1 1/2 years; added to this is 6 months to assemble production equipment, 6 months to prepare the site, and 6 months for construction, for a total of 3 years.

Important industries, research organizations and administrative agencies are often allocated special building funds to help them provide better housing for their personnel. Also, as an incentive to the workers to move east into the industrial complexes of Siberia, a relatively greater share of housing funds are funneled to that region, so that there will be better living conditions and amenities than in western USSR.

Urbanization has been proceeding rapidly in the Soviet Union. Urban inhabitants were only 18% of the total population in 1917; they now comprise 62% of the population. This coupled with the destruction of 40% of the housing stock in the USSR during World War II, has meant that in recent years housing has been the top priority in capital investment. Since the majority of the new housing has been built in mini-districts, districts, and entirely new towns, there has been a concomitant necessity for schools, hospitals and other community facilities, and these generally have accompanied the building of the housing complexes.

The location of new towns or large new districts on the edge of an existing city is determined by the planning group in that city and approved by the republic. However, it must be noted that housing construction continues to fluctuate with the rise and fall of the pulling power of the major claimants for capital funds, such as heavy industry, the military, high priority scientific research, and agriculture. New towns or districts are planned so as to minimize the commuting time of those living in the area. At present the average commuting time in Moscow is 70 minutes each way. The newer apartment building complexes have shops, either on the ground floor or in adjacent buildings, and new factories or commercial establishments are scheduled to be located in the immediate area. A combine (or trust, occasionally) usually will be given the responsibility for all housing construction and occasionally even the industrial building in a given area. The combine will then manufacture the panels, beams and other structural components and erect the buildings. The speciality trades will be subcontracted by the combine to a trust. The city ministry has the responsibility for the settlement of the district or new town. The residents are selected by the city administration. Some will come from waiting lists for larger apartments or change in location, some will be moved from existing plants because of a particular technical or craft skill, and others will come from older buildings to be demolished in another section of the city. The important point is that no one moves or even trades apartments privately without the approval of the city government.

The authorities are trying to move the factories out of Moscow and east to Siberia, so that the space in Moscow which the factories now occupy can be used for homes to be built for the additional service-type workers who are needed to eliminate the queues which the consumers must suffer to get service at stores, restaurants, etc.

• Individual Ownership and the Collective Farm

Private individuals may build single-family dwelling units, or a cooperative of several individuals may own a small apartment house, all being subject to the supervision of the municipal authorities. There are restrictions on the height and size of the apartments or buildings, although the allowed space is somewhat more than that in the government-built housing. It is reported that private owners can borrow up to 40% of the building costs and have 10-15 years to repay it with interest around 1-2% per year.

Schedule PDB-1 (appended to this report) shows the USSR housing production during the last few years. Although the need for adequate housing is still great, production has tended to level off during the 1966-68 period. Private building for housing has remained at about 15% of the total, although a private party cannot own the land.

A collective farm is another means of obtaining housing outside the normal government-owned channels. The description which follows is not strictly pertinent to the study of the industrialized building process, but it is of interest from the standpoint of giving insight into a novel type of community organization.

• The Kodaky Farm

The concept of the collective farm was developed in 1929-30. Everyone on a given farm gives his assets to the "collective." Near Kiev a collective farm named Kodaky was visited. There are presently some 2,500 people occupying the new government-built-and-owned houses and land, and ultimately there will be 5,300 people. There are 15 such collective farms in the Ukraine Republic which hopes to have another 7 built within a year. Of the USSR population, 38% is "on the land." The target of these collectives is to have a village with all the amenities of the cities. This is an attempt to reverse the trend of the young people moving into the cities. Information on Kodaky follows:

1. Kodaky is 35 miles from Kiev, and a Kiev trust performs the construction which is mostly brick. Of the total construction labor, 10% is imported from Kiev and 90% are the nearby peasants who are in or will move into the village.

2. There is a school, shopping center, community center, meeting room and a lake for swimming and boating. All the houses have telephones, electricity, water and central heat - a great improvement over the homes of older farm communities.

3. The distribution of land is 270 acres for residential use, 75 acres for industrial use, 125 acres for recreation or green area, and the crop fields are close by. The total farming area is 7,000 acres, of which 700 are for cattle and 6,300 is arable land for crops.

4. The distribution of the arable land is as follows: 25% for winter wheat, 25% for barley and peas, 18% for sugar beets, 6% for cabbage, and 26% for maize and fodder.

5. The houses are in four styles. There is a one-family house of one story, a two-family house of one story, a one-family house of two stories, and a two-family house of two stories. The house size averages approximately 900 ft^2 per family. The families in farm villages are slightly larger than families in the

cities, and probably average four persons per family.

6. The people who live in Kodaky came from a nearby village where they lived in log cabins. Of the 2,500 people living in Kodaky, 650 are working on the farm.

7. Each family gets 13,000 ft^2 (almost one-third acre) to grow its own crops - anything the family wishes. In addition, each family gets 1.2 acres for orchard or anything else it wishes to grow on it.

8. In addition to the land, Kodaky has 1,500 cows, 1,800 hogs, 1,650 sheep, 3,000 chickens - all for the personal well-being of the farmers. Milk is sent 12 kilometers to the milk plant. In addition, there are 100 horses, 35 tractors, 9 combines for wheat, 8 combines for beets, 3 cornpickers, 33 automobiles, 100 different motors for power.

9. The farm makes a year-to-year "profit" and the collective can buy new machinery or put in new buildings for public use with its profit. In 1968, out of total sales of 1,328,000 rubles, the combine (farm) claims to have made a "profit" of 480,000 rubles. Of the "profit," 25% is used to construct new houses or to purchase new equipment; 18% is used for fuel, fertilizers and seeds; 45% is used for salaries; 4% for state tax and 8% for cultural expenses such as nurseries, kindergartens, summer resorts and the like. The foregoing is not all profit according to US terms, but the important point is the farmers can use their "profit" for improvement of their standard of living.

10. As far as farm populations go, the people of

Kodaky are living very well. One of the one-family, two-story houses was visited. The place was spotless, and although the features such as light fixtures, plumbing and kitchen equipment were 30-40 years old by US standards, at least these farmers have reasonably good amenities relative to normal low-income farm standards even in the US.

ORGANIZATION FOR AN INDUSTRIALIZED PROCESS

Land use patterns (high population density in cities) and construction labor shortage require high-rise apartment buildings with small apartments. This leads to either steel or concrete construction. Since steel is in very short supply relative to concrete, and since concrete or brick requires less skill than steel construction, concrete is the preferred basic structural material. Because of the severe winters in most of the USSR, cast-in-place concrete construction is more costly for year-round construction than concrete panels, boxes or trusses prefabricated in a factory; and the quality is easier to control in a prefabricated unit. The term "box" connotes a three or four-sided set of room walls (with or without floor or ceiling) poured in a vertical set of molds so that the joints are continuous. Thus, prefabricated concrete panels, boxes and trusses (cast in a factory) are used for almost all building construction, although in some areas there is a relatively small amount of brick construction.

- Gosstroy Conclusions

USSR Gosstroy considers obsolete the system of one organization to supply the prefabricated panels, boxes, beams and windows, and another organization to construct the building. Accordingly, there has begun a change to a system of turnkey responsibility on the part of the factory "combine" where it must be responsible for the construction as well, even though it may subcontract some of the specialty work. Within the Republic (and, in some cases, city) Gosstroys, there are now various "combines" which have panel-box-truss-beam factories, erection crews and finishing crews. There are "trusts" that perform the specialty construction work (plumbing, electrical, foundations, etc.) as subcontractors to the combines. The panel factories have architects on their staffs, but they have only a minor role, as essentially all design is furnished by the Republic or City Gosstroy.

It is planned that more than 37% of the total housing and industrial construction will use the prefabrication system. This seems low at first, but the "total" includes construction for heavy industry, highways, dams, etc.

The major factors leading to USSR Gosstroy's conclusions on this choice of housing and factory construction method have been based on reported experiences as follows:

1. 40-50% less labor consumption versus conventional methods.

2. 30-45% less time to construct versus conventional methods.

3. Practicality of year-round construction.

4. Overall cost savings of 5-20% with prefabricated panel construction versus conventional construction.

5. Better quality with panel prefabrication.

Other sections of this report discuss these items in more detail.

For apartment buildings above 9 floors, the most economical method now is loadbearing panels with approximately half of the total labor spent in the factory. For apartment buildings up to 9 floors, the most economical method is the box system with 70-75% of the total labor spent in the factory. Over the entire country, the emphasis is on constructing plants to make boxes for apartment buildings up to 9 floors. Gosstroy has concluded that these will eventually be more economical overall than the panel-type construction. Gosstroy predicts that the total labor input for the finished unit built with the box system will be less than half of that required for one built by the panel system. The combines and trusts contract with the Republic Gosstroy (such as the Ukrainian SSR) to make the products or build a structure for an agreed price. Any profit which the combine or the trust makes is returned partly to the State (USSR) and partly to the combine or the trust for additional employee benefits such as bonuses, an expanded nursery for the children of women workers or additional amenities at the vacation resort which the combine may "own."

One combine generally builds most of the buildings in a given area. It is claimed that each combine knows how much construction is to be authorized for an entire year, and 30 days in advance of its needs the combine tells the authorities how much raw material will be required.

Warehouses are not maintained at the building site and there is only very limited storage area at the factory and construction site, so that the integration of production, trucking and continuous erection is a very serious problem. The combination of only 30 days' advance notice for materials and inadequate storage system, may be the principal reasons for the US team's observation of tremendous number of idle cranes and incomplete construction projects with no workmen in sight.

• Typical Glavleningradstroy

A typical City Gosstroy organization is Glavleningradstroy (Leningrad City Building Department) with 6 combines and 20 trusts:

5 combines produce panels and erect them, including bathroom elements for housing
1 combine produces panels and erects schools, nurseries and kindergartens
12 trusts erect brick and poured-concrete buildings
8 trusts perform specialty subcontract work, i.e., site clearing, excavations, foundations, sanitary, electrical, mechanical, and parts of the finishing of erected structures.

Production from these combines and trusts this year will total

50,000 apartments
20 schools
30 kindergartens and nurseries
5 movie houses
shopping centers, hotel, sports palace and utility lines

Most of the apartment buildings are 6-9 stories, but the next, "near-future" generation will be 16 stories.

Typically, House Building Combine No. 2 of Glavleningradstroy manufactures the panels for apartment buildings, delivers and erects them and finishes the buildings. The combine subcontracts the excavation, foundations and electrical and sanitary work to various trusts. The combine is divided into two principal departments: one for fabrication of the panels, and one for erection. There is one general manager over both departments. Other departments within the combine consist of

Administration and Transport

Economics

Engineering and Safety

Planning

Accounting

The integrated or turnkey responsibility for the combines is not a universally accepted principle. It is believed by Moscow Combine No. 9 that one firm should build all of the parts, i.e., the panels and boxes, and that another should specialize in assembly at the site. Those who agree with Combine No. 9 concluded that this practice will force each supplier of panels and other materials to meet quality specifications, thus preventing any "covering up" use of questionable or reject material. The US team's observations supported partial agreement with this, but the proper control of a turnkey operation can eliminate the problem cited by Combine No. 9.

Building materials other than prefabricated concrete and bricks are produced under the various city or regional ministries. A typical one is the Administration of Building Materials for Moscow (Glavmospromstroymaterial). It has 106 factories with 25% of them located in the city and ships 190,000 tons of material per day. Its products include sand, aggregate, doors, windows, hardware, etc.

Heat for the apartment buildings comes from one of the central station power plants in and around the outskirts of the city. These plants supply hot water at 195°F for space heating and this is reduced to 86°F for domestic use. The hot water is transmitted in pipes installed in underground concrete conduits which may also convey domestic water, gas and electric services. The power plants generally burn oil, but the fuel in Moscow will be switched to natural gas if sufficient amounts can be obtained from the Arctic

Circle-Ob River region and from Bukhara in Uzbekistan. The burning of coal is not permitted anywhere in Moscow because of concern about air pollution; oil will be eliminated as soon as natural gas is available, so as to get rid of the sulphur dioxide problem.

Once an apartment building or complex has been completed and the tenants have moved in, the city is usually responsible for its maintenance. There are janitors, gardeners, and maintenance people available at all times under the city administration. The tenants themselves form a group with self-appointed leaders to negotiate changes with the city and to accomplish whatever self-government is necessary from the standpoint of tenant behavior.

The USSR polls the tenants periodically to get their views on the design and quality of their apartments and apartment buildings. Trends in answers are observed, and it is claimed that changes in design are often made accordingly.

SPACE FOR LIVING

During World War II, 40% of Russia's housing was destroyed. Prior to World War II, a Russian lived in a log cabin or shared an apartment with one or two other families; some of these log cabins or apartments did not have running water. In the 1950's the transition to multistory apartment buildings was the only answer to an urgently needed housing supply, but it was normal even then for two or three families to share a bath and kitchen. In the 1960's it was possible to build enough new apartments and remodel older buildings to enable most of the families to have their own kitchens and bathrooms. But a newly married young couple still finds it necessary to live with one set of in-laws for a year or more before their turn on the waiting list yields an apartment. Moving from one apartment to another must be approved by the authorities and it generally takes many months to get approval.

- Standard Sizes

With few exceptions, the apartment buildings have a mixture of people from all economic and social strata. Mechanics, factory managers, professional people and academicians have apartments side by side and across the hall. The size of the apartments is determined by the number of people in the family. The only distinguishing feature may be in the furnishings and possibly in more expensive fixtures.

The Soviet citizens appear happy to accept these facilities, which are tiny and of poor quality (both in design and construction) relative to US standards -- the plumbing and electrical fixture designs are those used 30-40 years ago in the US -- because the apartments are so much better than anything they had formerly. Only a small fraction of Soviet citizens have seen directly how people live outside the USSR. Furthermore, since the buildings are filled with a complete social and economic mix of families, and since the only thing that determines the size of the apartment is the number of people in the family, when one man visits the apartment of someone of higher economic station he may see better furnishings but he will see no other difference. Perhaps this situation tends to minimize economic and social unrest.

In referring to the area of an apartment, the USSR has traditionally considered only "net living space" - the area of the living room and bedrooms. Conversion factors (meters, feet, etc.) and calculations for living space terms are given in Schedule PDB-9. The term "useful living space" (net living space plus kitchen, bathroom and inside hall) is used only rarely now, but will become standard "in a year or so." The ratio of useful/net living space ranges from 1.3 to 2.0 depending on the number of bedrooms, and the average is 1.45 for the new apartments for which data are available in the major cities (Schedules PDB-2, -3, -4, -5, and -6). The total area of the apartment building is never referred to, but for the average building, the apartments total 80% of the area and the elevators, stairways, lobbies, garbage chutes, laundry, utility room and storage occupy the other 20%.

The current goal is to reach a national average of 9 square meters (97 ft^2) of net living space for each person in the family by 1970. This means a total apartment size of 560 ft^2 for a family of four people. However, apartments built before 1965 have significantly less than this, and even some of the apartments being built in the major cities have up to 10% less than this. These numbers equate to overall square-foot-per-occupant areas averaging approximately the same as US HAA minimum public housing standards and approximately 60% as much as HAA maximum public housing standards (Schedule PDB-8). The quality and amenities of USSR apartments are below US HAA standards. Further, it must be noted that these USSR apartments are not for "low-income people" in the US sense, but for people in every economic and social stratum. The goal for 1985 is 15 square meters (160 ft^2) of net living space per person, which equates to an apartment area of 940 ft^2 for a family of four.

The currently published statistics for urban population in the USSR show an average of only 7.4 square meters of net living space per person compared with the 1970 goal of 9 square meters per person. The housing under construction averages slightly more than 9 square meters of net living space per person, so there is no chance of meeting the 9 square meters average before 1975-80. Gosstroy officials admit that major design changes take from four to ten years from concept to completion of construction. Accordingly, there would appear to be no possibility of meeting the goal of 15 square meters for at least 25 years even if the current construction rates shown in Schedule PDB-1 are increased by 50%. The chapter on Economics discusses this item further.

On the positive side, however, is the significant improvement which has been effected in raising the national average of 5.3 square meters of net living space per person in 1957 to 7.4 square meters per person in 1969. An indication of the importance attached to housing is the Gosstroy statement that dwellings represent half the cost of all new construction in the Moscow area.

After January 1, 1970, the use of the term "net living space" (living room and bedrooms) will be abandoned, as the USSR now recognizes that "useful living space" (the total area of an apartment) is a more meaningful term.

• Rent

The tenant's rent is 13 kopecks per square meter (1.3 cents/ft^2) of net living space per month. Electricity is metered; the other utilities are charged pro rata for the entire building. Utility costs vary, with an average of another 13 kopecks/m^2 net living space per month. Thus, a family of four may move into a new apartment (Schedule PDB-8) and have 40 square meters of net living space (equivalent to a useful living space of 630 ft^2) for which the rent would be $6 per month and the utilities another $6 per month. The rent covers approximately half the maintenance and operating cost of the building. The tenant pays nothing on the construction cost; the USSR theory is that it is the State's responsibility to house its citizens. Based on a typical monthly wage of $120, the rent amounts to 5% of the total income and utilities are another 5%. However, the real percentage is lower, because almost all women work and a wife's wages average $90-100 per month.

• Planning for Housing

Introduction of the prefabrication-type of building in recent years has required extensive changes to the standard designs and this has caused a shortage of architects. Although it is claimed that there are 12 different designs of apartments used throughout the USSR, by US standards they are essentially uniform, box-like apartments inside and out. The smallness of the rooms accentuates the fact that they have essentially no storage space; generally the practice is to use a wardrobe as a piece of furniture inside the room.

Gosstroy admits that there is not enough flexibility now in the modules, and that the atmosphere is dreary, even though there is a rule that the building must be oriented so as to ensure that every room has at least three hours of sunlight per day during March. There is also particular concern in the planning of large residential complexes to ensure adequate "green areas." For instance, in Kiev Combine No. 1's complex, to house 40,000 people, buildings will account for 20% and green space 80% of the total area of 275 acres. With the first of several apartment buildings finished, there have been complaints from the tenants on the noise from ground-floor shops which are in the same buildings with the apartments; in the future, the shops will be in separate buildings.

Leningrad Combine No. 2 builds only 9-story apartment buildings with one elevator (5-person capacity) per staircase. No. 2 plans to soon go to 12-story buildings with two elevators per staircase. One can have different building arrangements, but always with the same apartment layout internally. Each floor around each staircase has four apartments. There are six staircase sections to a total building complex with, typically, 216 apartments, with the apartments of either one, two, three or four rooms for living (defined as living room and bedrooms, exclusive of hall, kitchen and bathroom). Schedule PDB-2 tabulates a typical distribution of area and rooms for this Leningrad building.

There are 1.5 million people in Kiev. There are 15 separate housing complexes (districts) under construction; a complex accommodates up to 60,000 people and includes the shops for their daily necessities. Three more complexes will be started shortly. In Kiev, the present net living space is 8.7 square meters per person which is significantly higher than the USSR average of 7.4.

The "Apartment House of the Future" (a structure not yet complete) was visited in Moscow. Gosstroy feels it may be popular 50 years from now. There are two separate apartment buildings (approximately 200 feet apart) connected by a service wing. In this wing are the nursery, nursery school, laundry facilities, snack bars, grocery stores, etc. The individual apartments will have no kitchens, but each floor will have a communal kitchen.

The US delegation visited a 4-year-old, 5-story walk-up apartment building complex in Moscow (an elevator is now required for buildings 5 stories and over).

1. The apartment of a professor was visited; both the professor and his wife work. It is, of course, well publicized that most wives in the USSR work. It is interesting to note that 57% of Moscow's total population works, and that in the cities of European USSR, the families of child-bearing age average only 1.1 child per family. There are four in the professor's family and they are alloted 36

square meters (390 ft^2) of net living space: one bedroom with twin beds, one living room with a foldaway bed for an adult son, a bedroom den where the teenage daughter studies and sleeps, a kitchen, a bathroom and a balcony. The gross area of the apartment is approximately 580 ft^2. Newer apartments are 10-20% larger (Schedule PDB-2). The professor's salary is approximately $300 per month and his wife's salary is approximately $150 per month, both much higher than the average.

2. The apartment of a factory worker was visited. Both the worker and his wife work. He has one less room than the professor because he has only one child. The factory worker's salary is $120 per month, and that of his wife approximately $80 per month, both about average.

3. In this building, the exterior quality was approximately the same as that of US public housing built 10-15 years ago; the building had wood window frames and very crude galvanized sheet window sills which could not possibly prevent in-leakage. The apartments themselves were spotless, and the grounds quite clean and simply landscaped, although lawns were not well maintained - an observation applicable to most places visited. A nearby municipal power plant transforms back pressure steam into hot water for both space heating and domestic hot water service in the apartments. The hot water is transported by a concrete pipe to the apartment building. Galvanized pipe is used inside the building.

4. It was stated that in this apartment complex, as in all others, there is no preference or distinction as to location of tenants. The professor, factory worker, and even the plant manager could have apartments next to one another. The size of the man's family determines the size of his apartment.

• Tashkent - a City Reborn

Tashkent, the capital of Uzbekistan, is Russia's largest city after Moscow, Leningrad and Kiev. At the time of the devastating earthquake in April 1966, Tashkent had 1,100,000 people and covered an area of 70 square miles. It now has 1,300,000 and a population of 1,500,000 is projected for 1980.

The population is much larger than it might have been under normal circumstances; during the war, 1,100,000 refugees came to Tashkent and many of them stayed. Also during the war, many of the factories had been moved there from western USSR and they, of course, remained in production. The authorities wish to slow the rapid population growth in Tashkent (the Uzbek people have more children than most other races throughout the USSR), so no new factories will be built in Tashkent other than those needed to supply materials for the construction of residences.

Of Tashkent's 1,300,000 people, 400,000 must be moved by 1980 to accommodate the master plan which calls for the center of the city to be occupied by public buildings and parks and other areas with extensive green spaces. The center of the city was the epicenter of the 1966 earthquake and the Administration has explained to the people that the forced move is on the basis of "public safety."

Before the earthquake, most of the houses were old and of one-story adobe-and-straw construction. Buildings that had been constructed recently according to special "seismic" specifications withstood the effects of the 1966 earthquake. Most of the other buildings cracked and fell. During the earthquake, which was a vertical-push type quake, one-third of the total living area was destroyed, and another one-sixth was damaged to the extent of requiring demolition. There were 96,000 apartments, 225 nurseries and kindergartens, 181 schools and 118 medical facilities destroyed. Aided tremendously by the other Republics which brought their workers and their factory products to Tashkent, 23,000,000 ft^2 of housing and 15 schools have been constructed within the last two years. The major Republics such as RSFSR, the Ukraine and Byelorussia, have each taken responsibility for the reconstruction of an area of the city.

At the present time in Tashkent, the net living space amounts to 6 square meters per person (versus 7-9 in other major USSR cities), largely because of the tremendous damage during the earthquake. The new goal is 12 square meters of net living space per person, but the date of realization was not stated. Now, at least, everyone has a roof over his head in spite of the 1966 earthquake.

A typical neighborhood unit of apartments in Tashkent has generally 6,000-8,000 people and sometimes 12,000. It has schools, shops and other amenities. Several neighborhood units form a living area of 40,000 people. The 12,000 people of the neighborhood unit are generally figured at four persons per family, and they live in 4-story and 9-story apartment buildings. Throughout most other developed parts of the USSR, family size probably averages close to 3.5 persons per family.

For the Tashkent area, there are two principal building schemes being considered:

1. a nine-story prefabricated panel type
2. a precast or cast-in-situ concrete frame with curtain wall; the frame and floor slab form the diaphragm.

There seems to be a "design" preference mostly for the latter on account of the need for a light structure for earthquake resistance.

The Tashkent area has both a very hot and a moderately cold climate and is earthquake prone. Structural design is for the Russian Seismic Scale Intensity 7, 8 and 9 (Schedule PDB-7). Seismic Intensity 9 is approximately equal to the Mercali scale in number and is equivalent to the Richter Zone 12. The normal design was for Intensity 8 until 1966, the year of the devastating earthquake; now the design is for Intensity 9 which calls for very simple construction and residential buildings limited to a maximum of nine stories, although municipal buildings of 22 stories are planned. The thickness of the exterior walls is based on accommodating a summer temperature of 99°F (it often reaches 110°F); this thickness is sufficient to accommodate Tashkent's winter low temperature of 9°F. Orientation of the building is also important: there must be ventilation through the building since air-conditioning is rare now and not scheduled for extensive use, and usually there is very little wind. With proper orientation, the difference in temperature from one side of the building to the other creates air movement through the building. Formerly, the ceiling height was 8 ft-5 in, but in deference to the hot climate, this has been increased to 9 ft-4 in. Adding the floor slab to this yields a floor-to-floor distance of 9 ft-10 in.

Some of the newer housing areas in Tashkent have a central heating plant for several apartment buildings. There is also a chilling plant nearby which pipes cold air to the buildings. Only those housing developments without natural draft ventilation will be allowed to have this so-called air-conditioning. The relative humidity is quite low, and the practice of having recessed balconies helps to give shade "in the open." Many of the people sleep on the balconies. The urbanistic demand (high-rise apartments) prevents the innovation of the patio; it is also too expensive to use the roof of the apartment below as a patio for the apartment above.

Even though the apartments are very plain and the quality of workmanship is low, the authorities maintain that the people who formerly lived in adobe huts think the new apartments are wonderful. The Tashkent authorities have had very little trouble with the people who have moved from adobe huts into these new apartments, and they have been maintained quite adequately by the people living there.

Glavtashkentstroy is experimenting with a one-family, two-story cottage of prefabricated panels for those families with many children. This is the least economical form of construction in the cities. It costs 20% more per square foot than a four-story apartment building and 10% more per square foot than a nine-story apartment building. The unit cost of a nine-story building is more expensive than that of a four-story building because of the elevator that is required. This experiment may work in the villages because there is plenty of land available and the pressure for high-density development is much less than in the cities.

As another experiment, Glavtaskentstroy is building a special small city (full scale, but excluding the sanitary facilities) of panel construction, brick construction, multi-story construction, etc.; there are 80 test buildings altogether. An earthquake of Intensity 9 will be caused in 1970 by exploding 2200 tons of TNT at 250 feet below the surface. The epicenter of the earthquake will be 430 feet from the center of the model city. A nuclear detonation was considered but cancelled because of fear of subsoil and water contamination.

PART II

PRODUCTION AND CONSTRUCTION

For the USSR, the advent of the industrialized building process is a blessing because of the low housing construction base from which the start was made, the relatively small number of skilled craftsmen required, vs. that for conventional building, and the fact that the use of prefabricated concrete components makes it possible to construct buildings with far less total labor input than would otherwise be required. The trend of housing construction in the USSR has been impressive as to volume - it <u>had</u> to be, with 40% of all USSR housing destroyed during World War II. Schedule PDB-1 tabulates the USSR housing construction by years. The 1968 figure of 102,100,000 m^2 net living space is equivalent to 190,000,000 m^2 total housing area or 2 billion ft^2 total housing area. By comparison, the estimate for 1968 US housing construction is 1.5 billion ft^2.

The use of the term "industrialized building process" in Russia refers (1) to the prefabrication (generally in a production plant and occasionally at the construction site) of structural components such as slabs, panels, box units, beams, girders and trusses; and (2) to the construction of large numbers of buildings using these components so as to ensure the efficient use of the factories producing them. The box unit production has been limited essentially to small bathrooms, although there has been some experimental work done on box-shaped rooms. The manufacture of these components is highly industrialized from the standpoint of using batteries of vertical molds, horizontal molds on moving production lines, accelerated curing and detailed and sophisticated erection scheduling so as to minimize storage requirements.

The USSR has concentrated on three structural systems:

1. The vertical loadbearing system for housing
2. The column-beam-truss system for commercial and factory buildings
3. The box system for housing (currently under test)

In the vertical loadbearing system the floors and roof form the horizontal diaphragms and the wall panels act as vertical diaphragms. The foundations are cast in-place and the loadbearing elements are wall panels which in almost all cases have been prefabricated at either a plant located at the construction site or, more often, in the vicinity of the site. The highest buildings constructed in the USSR using this principle have been 21 stories, but plans have been made for 30-story buildings. The wall panels are generally of one-story height; the floor slabs are generally precast, and occasionally cast in-situ. Normal weight concrete is used most often, although in many cases lightweight concrete is used. Exterior panels can be faced with embedded decorative tile or glass mosaic, or painted. The door and window openings are provided by inserts in the castings. In many instances, piping and wiring are embedded in the panel. Slabs and panels weigh an average of 5 tons up to a maximum of 10 tons. The normal vestibule includes stairways, landings, and elevator entrances. In many instances the stairways are precast at the factories and installed as units for each floor or half floor.

The column-beam-truss system for commercial and factory buildings has been used for buildings of up to 10 stories. The main precast elements are single-story columns, span beams which support either precast or cast-in-place floors, crane girders, roof and wall panels. With respect to non-housing construction, there is much to be learned from the very lightweight trusses fabricated for and accompanying interesting building design in the USSR. However, these special designs are not considered in the context of this study to be the industrialized building process or to be any different from our normal US practices of designing for either concrete or steel trusses.

Box unit production has been limited essentially to bathroom units with the sides and ceiling cast as a unit in vertical molds at the factory; units weigh up to 10 tons and are made of normal concrete. These sanitary units include the toilet, washbasin and bathtub; in most cases the plumbing is connected at the factory with piping exposed. Structurally, the units act as conventional load-bearing planes with integral connections at the corners.

Some recent buildings have been built with experimental box units as full-size rooms. These are used primarily in apartment buildings. The vertical loads are carried at the heavily reinforced corners of the box, thus permitting large openings in the walls when needed to open the interior space. Some of the largest boxes weigh 25 tons which is approximately the current maximum transportable weight. These boxes would be approximately 15 feet long by 10 feet wide by 8 1/2 feet high, with wall thicknesses up to 9 inches. The largest box being considered for the immediate future is reported as 20 feet long by 10 feet wide by 8 1/2 feet high, with walls thinner than 9 inches. The ultimate target is a box 26 feet long by 16 feet wide which would weigh 28 net tons. There is no unanimity of opinion among USSR officials as to the relative economic and technical advantages between panel and box construction although most feel that the box type will ultimately be cheaper. Only continued experimenting and full-scale building with each type will point to the correct answer.

In the cities, most of the apartments are concrete. It is interesting to note that USSR Gosstroy claims that maintenance problems involved with these apartments are mostly from poor design or construction rather than from tenant misuse.

Even though brick is the second most widely used building material, the industrialized building process has not been applied to this material. Manual labor is still used for essentially everything concerned with brick construction. This is possibly an advantage in rural areas far from major cities, where factories do not exist for the manufacture of concrete panels. While attempts have been made to develop highly mechanized and automated brick plants (including processes for prelaying walls), no success has been attained with respect to any kind of prefabrication of brick panels. In the rural areas most apartment buildings have been brick, but the trend even there is to concrete because of economy. Because of esthetics in Leningrad, where fine old public buildings are of brick, there is still a considerable amount of brick being used. However, wherever the US team went throughout the USSR, officials stated that brick will become a minor building material.

Concrete block is used only sparingly on account of the heavy labor component used to build with it which makes it uneconomical compared with panels. One of the principal uses for concrete block is in repair work.

There is very little housing or any other building made from wood in the urban or even rural areas in the USSR other than in remote areas of Siberia. Structural steel is in such short supply that it is not used extensively for building construction.

Aluminum, plastic pipe and other plastics, polymers (i.e., linoleum) and glass are in such short supply in the USSR that they are used very sparingly; no aluminum or plastic is available for use on apartment houses.

Because of the shortage of skilled construction craftsmen, the goal is absolute minimum labor at the building site. It is claimed that the industrialized building process effected by the USSR results in 40-50% less labor input overall (due to the repetitive nature of the work and that much of it is done in the protected atmosphere of the factory) and 30-40% less construction time for the average building.

Until the disastrous 1966 earthquake, Tashkent was a city of very old one- or two-story, adobe-and-straw buildings. The earthquake demolished almost half of them. Of the buildings constructed since the earthquake, panel-type construction in Tashkent has accounted for 60% of the total housing and 70% of the schools, and it is planned that these numbers will reach 80% in the near future. After 1981, 100% of all the houses, schools, nurseries, and factories will be of prefabricated concrete panels and slabs. This trend is typical of all of the USSR cities.

PREFABRICATING PLANTS

The USSR is using extensively the conveyorized technique for producing large elements out of reinforced concrete. In one type of continuous-production plant, forms on a two-level conveyor pass through stations for the various operations in the preparation of a panel. Heavy steel forms have made it possible to effect good edge control and curing of the concrete panels. This type of production line produces load-bearing as well as non-loadbearing panels and slabs with good exterior appearance and complete fabrication within the plant. Also prestressed, precast components can be produced economically on these lines.

The two-level conveyor type line consists of a horizontally traveling conveyor with the heavy metal forms resting on the conveyor. The sequence of operations is as shown on Figure PDB-1 (see Appendix PDB-1) and starts with cleaning and oiling of the form, and placing the reinforcing steel conduits, piping and blockouts before casting the concrete. The next set of operations involves the pouring and vibrating of the concrete followed by screeding and trimming of the waste. Following this is the preheating of the freshly poured panel, the removal of blockouts, and curing which takes place at the end of the floor level operation of the conveyor and lowering by elevator to the below-floor level for more curing on the conveyor. There is a cooling phase followed by elevating the form to the floor level again, after which the mold is stripped of its panel.

For the prefabrication of building panels mainly, and also other concrete products, there are 106 plants throughout the USSR (28 in the Moscow area alone), mostly conveyorized. Production ranges to 250,000 cubic yards of product per plant per year which is equivalent to approximately 15,000,000 square feet of product per year, which, in turn, would be enough for 5,000,000 square feet of buildings containing 7,000 average-size USSR apartments. The size of the panel is limited only by the capacity of the elevator taking it from one conveyor elevation to another, the capacity of the plant crane, the capacity of the truck for transportation to the job site and the capacity of the cranes at the job site. Further details on the conveyorizing of panel production are given in Appendix PDB-1. This is a translation of Chapter 2 of a book entitled "Technical Progress in the Industry of Construction Materials of Moscow," dated 1967. The title of Chapter 2 is "Industrialization of Completely Fabricated and Precast Concrete Housing Construction."

Most interior wall panels are cast in vertical molds at the prefabrication factories. These vertical molds are of the battery type with internal leaves forming anywhere from 2 to 10 full-size panels. The panel sizes are usually room length (but can be as much as 30 feet long) and 8-9 feet high. The concrete is poured into the mold from overhead hoppers. The internal vibrators are generally hand-operated by men or women standing on top of the vertical molds. Curing in the molds is done through the end panels of the mold as well as the so-called "leaves" in between each mold. While extremely good finish and dimensional accuracy is possible with this kind of mold, the panel-handling practices after stripping left much to be desired as far as maintaining quality. We observed many instances of chips and dents in the panels which could only have occurred subsequent to stripping.

The plants are spacious - there is plenty of room for reinforcement fabrication as well as the concrete panel fabrication - and they are reasonably clean.

It is claimed that the panel plant can accommodate a "model" (panel dimension) change every three to four hours. With respect to an innovation in the production process, it requires a minimum of four months and possibly as many as 18 months to get all the necessary state, republic, city and combine approvals to get materials allocated, machinery altered and to begin production. To effect a basic change in apartment size or layout requires four to ten years.

While most of the production line equipment is heavy and relatively inflexible by US standards, it appears to be well suited to USSR requirements; the plants were designed for truly mass production of standard sizes of products for a very uniform design of building which has been repeated year after year with few basic changes. As noted elsewhere, the plant manager is in the enviable position of knowing one year in advance what his production is supposed to be, and that his sales are guaranteed.

• Moscow Combine No. 9 - an Integrated Operation

Moscow Combine No. 9's conveyorized panel plant (built in 1965 has two production lines each 320 feet long. There are 24 panels in varying stages of completion on each line at any one time. A typical floor slab would be 15 feet long by 9 feet wide by 5.5 inches thick. The production line is a continuously operating line with 12 panels on line at one elevation and 12 below the first 12; each panel is in a different stage of either pouring, finishing or curing. Each line manufactures 47,000 cubic yards of panels per year on 15 shifts per week. They do not use conduit in the panels, but use plastic-coated aluminum wire which is cast in place. The cement is "hi-early" cement; during the curing process, the panel stays one hour at 104°F and then five hours at 185°F; the total curing cycle is six hours.

The reinforcement cages are produced by continuous-feed reels, hand controlled welders and automatic cut-off machines.

Panel sizes vary up to 20 feet long, 10 feet wide and 6 inches thick, although some special panels are made up to 20 inches thick.

In addition to floor slabs, exterior panels with ceramic finish and light cellular 3-4 inch thick interior wall panels can be made on these conveyor lines, although production of the latter was not observed. The lines are located along the side bays of the shop building. The central bays contain the vertical molds, areas for fabrication of reinforcement "cages" and areas for cleaning ceramic facings and the finishing of other surfaces. The surfaces produced on both the conveyor lines and in vertical molds are suitable for whitewashing or painting of ceilings as well as for laying of linoleum or other tile for the floors.

For producing approximately 94,000 cubic yards per year of concrete panels, and 105,000 cubic yards per year of gypsum board inside panels 3 inches thick, Combine No. 9's plant employs 1,040 people total including those who operate the nursery for the children of the workers. Of these people, 840 are on production lines, of which almost half are women. The workers on the production line earn 150-170 rubles ($165-187) per month with the higher figure including the "above-quota bonus which is usually made." This income is significantly higher than the USSR urban average of $120 and is given as a reason for construction workers taking factory jobs. In addition, the workers get free nursery service for their children, free hospitalization and other amenities such as subsidized vacations at the Black Sea resorts "owned" by the plant.

Moscow Combine No. 9 also produces mill work from logs, glazes and paints the windows for the panels that it makes as well as for panels made by others. The woodworking machinery is of Austrian manufacture and is semiautomatic. The windows are all of wood because aluminum and steel sash give heat transfer problems in the Moscow temperatures which reach to 22°F below zero. The quality appeared to be excellent. This Combine also makes the parquet flooring and all of the built-in furniture for its apartment buildings as well as furniture for schools and hospitals built by others.

• Moscow Lightweight Panels and Infrared Curing

In Moscow Combine No. 1's plant, lightweight, curtain-wall panels are produced on the conveyorized production lines. The plant has an automatic lightweight concrete batch plant producing concrete of 60-66 lb/ft^3 from which panels 12-13 inches thick are produced. The lightweight aggregate is made of a low-swelling clay. Most of the exterior panels have a ceramic tile facing with the tile 2 inches square by 1/4 inch thick; other decorative material is glass mosaic. The carpets of ceramic facings are placed face down in the form, followed by approximately one-inch thickness of concrete mix before placing the reinforcing steel mesh. The form moves to a vibrating table where the concrete is poured and compacted. The rest of the process is essentially the same as for regular concrete panels.

A recent innovation for the purpose of producing lightweight, double module exterior panels is the practice of "quick stripping" after casting and curing through the use of infrared rays which accelerates the curing process and allows stripping the panel from the form within 6 1/2 hours (1 1/2 hours at 140°F and 5 hours at 203°F). The compartmented chamber consists of a concrete tunnel built above ground. Inside, above and along the sides of the chamber electric heaters of the tube-type emitting infrared rays are mounted. These particular chambers take the place of the long curing chambers indicated in Figure PDB-1 which require 8 1/2 hours for curing.

Some exterior concrete panels were painted with a polyvinyl paint which is claimed to last 8-10 years. The largest panels are 21 x 21 ft.

• Leningrad Panels and Boxes

The Leningrad House Building Combine No. 2 factory manufactures reinforced concrete panels and sanitary boxes. A sanitary box (bathroom) is a three or four walled assembly plus ceiling or floor cast as a unit and transported to the site.

1. The panel fabrication plant occupies 43 acres. The concrete moves by belt from the batch plant to the casting plant and is poured into the panel molds. On one of the production lines, the panels take five hours for curing out of a total cycle of eight hours which includes the finishing of the panels. The panels use a haydite type of concrete. A typical panel is 8.5 x 21 ft x 12 in thick. On another production line, the total time of manufacturing a panel is 12 hours which includes 8 1/2 hours for steam curing. Panel curing starts at 77-86°F, with a rise of 18°F every 20 minutes until it reaches the upper curing temperature of 194-203°F. Following this, the temperature is gradually reduced until the panel leaves the curing chamber at 68°F. One panel is finished every 22 minutes. The maximum storage area for finished panels is 3,000 units with the average storage time of one week.

2. The sanitary boxes are three-dimensional for the toilet cubicle, the bath cubicle and the heater cubicle. They are poured in vertical molds with the mold panels opening out; the interior form is tapered. Steam passes

through the inside form for curing. After mold stripping, in some instances, the box may have the toilet, washbasin and bathtub either totally installed or partially installed before it leaves the factory. The sanitary trust installs the fixtures in this box, whether done at the factory or at the construction site. The box is transported to storage or the construction site. Sometimes the plumbing is attached at the construction site. There is presently a wave of enthusiasm for boxes for rooms, kitchen-bathroom combined, as well as for bathrooms as described above, as it is claimed that there is a significant saving in overall cost when compared to panels.

Current plans call for constructing 28 factories for prefabricated concrete "boxes" in the Moscow region alone; these boxes would be for housing and stores, as well as sanitary cubicles. There are at present four operating "box" plants in the Moscow area. Each new plant will have a capacity to produce boxes for 2,000,000 ft^2 gross building area per year (3,000 USSR apartments).

• Kiev Panels and Structural Elements

Kiev Trust No. 1 (Brovary) makes large concrete elements (beams, trusses, slabs, panels) for industrial plants. Information on the plant and products is as follows:

1. Concrete is delivered from the mix area to the panel molds by rubber belt.

2. There is adequate space for reinforcing mesh preparation.

3. The trusses are poured in place in horizontal steel-jacketed molds with a curing time of 15 hours at a maximum temperature of 185°F.

4. 82% of the components are prestressed. One small tensioning machine has a 60-ton capacity and another has 500-ton capacity, the latter being able to pull all strands

at once.

5. Loadbearing wall panels are poured in horizontal molds and have a polystyrene wall insert for insulation. The vibration of the concrete in the forms is controlled by electric magnets which keep the forms from jumping. A large panel is poured every 30 minutes, which is equivalent to 14 panels per shift. The goal of this plant is 180,000 yd^3 of concrete panels per year. At present the actual production is 120,000 yd^3 of panels per year.

6. Concrete boxes for five-story housing are manufactured; the boxes are 10 x 16 ft x 10-12 ft high.

7. Most of the curing is accomplished by jacket heating of the molds, but it was stated that this is not as productive as ovens. A small amount of the panel production can be accommodated in a few batch-type ovens located in the outdoor storage yard.

8. There appears to be plenty of storage space for the finished panels.

Schedule PDB-3 includes a few statistics on panel plant production, manpower usage and panel sizes for Kiev Combine No. 3.

- Tashkent Combine DSK-1

Tashkent Combine DSK 1 information (Schedule PDB-7) is as follows:

1. The combine makes the panels, assembles them at the site, erects and finishes the building, including the roofing. Electrical, sanitary and foundation work is subcontracted to the various specialty trusts. For a typical 48-apartment house, the combine's materials and labor will represent 76% of the total cost of the building (the combine does not make its own windows). The other 24% consists primarily of foundations, electrical and mechanical work by subcontractors.

2. Factory No. 1, built in 1959, is clean, neat and not cramped; it makes heavy panels for four- and five-story houses. Its capacity is 300,000 m^2 of net living space per year (6,000,000 ft^2 total building area).

3. Factory No. 1 uses both vertical and horizontal molds. The vertical molds are cheaper, but less flexible. Panels can be poured and cured 6, 8, or 10 to a battery in the vertical mold. The prefabricated reinforcing steel, often including radiant heating pipes, is placed in the molds before pouring. With the horizontal panels, the windows (purchased in Tashkent) are cast in place. Both a batched and a mechanized horizontal-pour line are in existence, the latter now being under test. On the mechanized line, one panel is hoped for every 15 minutes. When the experimental line is "debugged", predicted capacity is 270,000 square meters of net living space per year (5,400,000 ft^2 total building area) based upon a steam-cure time of 4-6 hours.

4. Factory No. 2 produces panels for 200,000 m^2 of net living space per year (4,000,000 ft^2 total building area) with half of them for four-story buildings and half for nine-story buildings. All casting is in 90 horizontal molds. Heating of the molds is by electrical resistance coils attached to a cover placed over the panel. Curing time is 2 1/2-3 hours, during which the temperature is increased 72°F per hour up to the maximum temperature of 185-194°F.

5. The maximum panel sizes are 12 x 23 ft x 5.5 in thick for floors; 12 x 23 ft x 10 in thick for the exterior walls; and 12 x 23 ft x 19 in thick for the interior load-bearing walls.

6. No conduit is used for the wiring inside the panel, but the hole is made by pulling out a plastic pipe insert before the concrete sets.

7. The concrete mix is transported by cart to the

pouring hopper and this is admittedly not efficient.

8. At Factories No. 1 and 2, sand, gravel and cement can be received by either truck or rail. Cement is unloaded by air.

9. The total number of people at both factories is 1,700 including those operating the boiler plant, plus another 2,700 people at the various construction sites. Women constitute 37% of the erection and finishing work force.

10. The first nine-story apartment house built in Tashkent for Seismic Intensity 9 has just been completed by DSK-1. Previous to this they had been limited to only five stories.

11. Since 1960, Factory No. 1 has built panels for 1,500,000 m^2 of net living space which, on the basis of an average of 30 m^2 of net living space per apartment, equals 50,000 apartments.

12. The combine claims to be able to finish 162 apartments (4,900 m^2 of net living space) in 260 working days based on a five-day week. The average of 30.2 m^2 net living space per apartment is lower than in the other cities (Moscow, Leningrad, Kiev) for which statistics were available.

• Moscow Experimental Panel Factory

This plant makes panels for "advanced design" of experimental apartment buildings.

1. There are two experimental conveyor lines, each 300 feet long, 14 feet wide, and with movable steel molds fastened to the conveyor belt. The conveyor moves 100 feet per hour, including short stops for certain operations. Concrete is dumped onto the belt and vibrated, smoothed (by hand) and finished (by powered rollers) all in 15 minutes.

2. The reinforcing steel for these panels is prefabricated into "cages" and placed by crane onto the conveyor.

3. There is no limit to the length of a panel other than transportation to the construction site; the longest to date has been 46 feet. The panels can be anywhere from 0.8 in-14 in thick.

4. The total time to manufacture a concrete panel is 2 1/4 hours on the conveyor, including curing. Steam curing at a maximum of 185°F requires 2 hours of the 2 1/4 hours total time, and takes the concrete to 60% of ultimate strength. The steam curing takes place in a "vertical" oven which stacks the panels for the required time.

5. Molds are set so a top layer of lightweight concrete can be added to the regular concrete underneath; also, exterior decorative panels are made by putting the decorative material (ceramics) on the bottom layer and the regular concrete on top of it. Blockouts are used for openings such as doors and windows.

6. An experimental room built at the factory is used to determine whether an apartment building with this kind of production line can still be quite flexible with respect to module dimensions. The hot water supply pipe for space heating is embedded in a corner of the room; the radiator is hung on the wall under the window and connected to the hot water supply by exposed piping. The electric wiring is in a conduit in the slab, but it is planned to eliminate the conduit and simply pour concrete around a plastic covered electric wire. Panel tolerances are claimed to be plus or minus 5 millimeters, but this sounds impossible from what the US team observed.

CONSTRUCTION

• The Ukraine Report

All of the Republics have concentrated on developing rapid construction methods. The Ukrainian SSR has reported on some of its project experiences during 1968-69. The report, "Rapid Construction of Apartment Houses in the Ukrainian SSR" published by the Scientific-Research Institute of the Construction Industry, Kiev, 1969.* Information from that report is reviewed as follows:

1. A nine-story apartment house, in the Bereznyaki complex in Kiev was built in the period September-November, 1968. Details on this 144-unit apartment building are contained in Schedule PDB-4. The building was completed in record time of 60 calendar days (45 working days) for the above-ground part of the building. There is no information on the length of time for the below-grade work. The floor structures were erected in 18 working days, the roof in four days, and finishing work was completed in 23 working days. Appendix PDB-2 describes the construction schedule in more detail. This is claimed to be four times faster than the normally-specified construction time standards approved by the Gosstroy of the USSR. This is also twice as fast as the construction time achieved by the same house building combine in the erection of other houses in the same series.

Rapid methods in the erection of five-story apartment houses were also used in 1968 by the Donbass builders. As a result, a large paneled building of 60 apartments was built in 64 days, a 58- apartment building in 54 days, a

*A translation of this publication appears as Appendix D of this document.

45- apartment building in 50 days, and a 120- apartment building in 45 working days. To get calendar days for this, one would add 40% to these numbers. It should be noted that these numbers apply to the above-ground construction.

3. With respect to the Bereznyaki building (Item 1 above), the following description applies:

a. The outer walls of the house consist of one layer of claydite (light weight clay aggregate) concrete panels, 15 inches thick, made in 20 standard sizes. Claydite-concrete is used for thermal insulation. The panels are provided with precast window and door (to the balcony) openings. Outer surfaces of the panels are faced with ceramic tile. The inner walls consist of hollow, reinforced concrete panels, made in six standard sizes.

The floors consist of cross-ribbed reinforced concrete panels, made in six standard sizes of rooms. Partitions are made of rolled gypsum-concrete panels of room size. Three-layered roofing material comes in a roll; drains are internal to the building.

Floors are covered with parquet boards in living-rooms and bedrooms, vinyl in kitchens and entrance halls, and ceramic tile in bathrooms.

The house is furnished with a water supply, sewer system, hot water for heating and domestic use, gas for kitchen, ranges, telephones, radio and master TV-antennas, elevators and central trash ducts.

b. The erection crew consisted of:

Foreman VI Class	1 man
Erectors IV class	6
Erectors III class	16
Riggers III class	6
Mason-concrete workers IV class	2
Mason-concrete workers III class	4
Metal workers V class	2
Arc welders V class	4
Facade workers V class	2
Facade workers IV class	4
Carpenters IV class	2
Tower crane operators IV class	6
Total	55 men

Work integrated with the erection was done by five other crews which included 18 carpenters, 8 tile-layers, 16 plasterers, 8 plumbers, and 4 electricians. Finishing work was done by four crews of painters and two crews of parquet - layers. We have no information on the number of people on these crews, although many were women.

4. The report also describes the experience of the building of apartment houses in the Donetsk region of the Ukraine as summarized in Schedule PDB-5. These three buildings listed were given high priority for rapid construction. In essence, these particular buildings received special treatment from the standpoint of ensuring a steady supply of prefabricated materials, an adequate supply of labor, and obviously high-level concern for the construction schedule. Generally, the work was performed

on three shifts per day, five days per week.

During the rapid construction of apartment houses in Donetsk region the following difficulties emerged:

a. The prefabricated structures, parts and articles of large-panel houses were of poor factory finish, panel surfaces required plastering in some places, many door and window units were not painted or glazed, and in some there were no window sills.

b. Some of the fabricating plants and construction sites lacked sufficient storage space for storing the required quantity of prefabricated structures and other products, causing interruption in the rapid completion of some operations.

c. Supply of prefabricated structures and other articles was not organized properly, which caused interruptions in providing rapid construction with the necessary items.

5. Summarizing the experiences described in the rapid construction of apartment houses, the report draws the following conclusions:

a. The term "rapid construction" can be applied only to "production line" construction, in which the best possible combination of concurrently performed operations is achieved, the operations are mechanized to the maximum, and the largest possible number of workers is distributed on the site which results in a high technical and economic efficiency. Thus, in the rapid erection of four-section houses the erection work was done in two parallel production lines (two tower cranes), and finishing work was carried out in four parallel production lines (four crews) simultaneously in all four sections of the building.

b. For successful execution of rapid construction, a thorough preparation is necessary, which includes the following:

aa. Developing of plans for the rapid execution of work and acquainting the executives at all levels with them;

bb. completing installation of all underground pipes and cables, and construction of roads and approaches before starting the erection of structures of the above-ground part of the building;

cc. planning and taking the necessary steps to secure a constant stock of materials, structures and articles required for the construction of at least two floors;

dd. planning and taking the necessary steps to ensure uninterrupted supply of electric power, mechanization and transportation means, and their reliable functioning;

ee. organization of dispatching service, equipped with modern means of communications and control of the delivery of all kinds of materials and products from all suppliers;

ff. construction of job-site storage facilities for spare parts and transportation items;

gg. installation and testing of mechanized means for erection and other operations.

c. Plans for large-panel apartment buildings specify the extremely high labor-consuming nonindustrial practices, such as sand bases for floors with concrete topping, large volumes of wet plaster, roofing material in rolls and others which have to be eliminated, because they do not correspond with the requirements of rapid work execution.

d. To ensure high quality execution of finishing work in rapid construction, it is necessary to make provisions for artificial drying of the building.

e. As a rule, house-building combines and trusts operate without reserve production facilities. Thus, whenever there is a lag in the production of parts for the rapid erection of a house their shortage is made up at the expense of other construction sites. To eliminate the above-mentioned deficiencies, it is necessary for the DSK (combine) to set up reserve production facilities.

f. The existing supply departments of the house-building concerns do not have sufficient storage space for storing of the necessary quantities of reserve prefabricated articles, without which it is impossible to secure the continuous rapid execution of work. It is very essential that the DSK expand its existing storage facilities for the reserve-stock of prefabricated items and also that the funds are allotted for the construction of new shops for their supply departments.

g. To improve the supply of material and engineered items to rapid-construction sites it is necessary:

to increase the reserve-stock quotas of materials, prefabricated structures and products;

to organize acquisition at all plants supplying products to the trust or combine.

h. The S-419 tower cranes used in the construction of large-panel, high-rise houses do not correspond with the requirement of rapid erection of buildings, because they require a lot of time and labor for their installation, dismantling and moving. Rapid-construction sites should be provided with mobile cranes with revolving towers of the KB-100, KB-160-2 or KB-180 type.

i. High technical and economic efficiency is achieved in rapid construction. Erection time is reduced three to four times as compared with the standard method, labor-consumption is decreased by 0.3-0.5 man-day per m^2 of living space, and the net cost of construction is reduced by 4-5%. The number of buildings under erection at one time (specified in the annual program of a building organization) significantly decreases.

j. The rapid erection of buildings gives the opportunity to reveal the reserves and tight spots in housing construction, which are recommended to be taken into consideration in the organization of production-line method of building the residential blocks, and in the continuous production-line work organization of the DSK (combine) and the housing construction trusts.

While the foregoing is an interesting treatise on how rapidly a building can be erected under forced draft, with every asset concentrated on one thing at a time, it was quite apparent to the US team that normal construction takes much longer in the USSR. One key to this conclusion is the vast number of semi-erected or erected-but-unfinished buildings observed in each of the four largest cities in the USSR (Moscow, Leningrad, Kiev, and Tashkent) - and with one, two or three idle tower cranes standing alongside. It is a conservative assumption that for every crane working, there are ten standing idle with no one working at the site. At several places where the US team was inspecting a building being constructed, the USSR host would admit that construction had been in progress for a year or more - and this time did not include the below-grade work which is usually completed before the erection team from the Combine begins work. The delays in completion are due to shortages of (a) panels from the factories, (b) deliveries of items such as fixtures and windows, and (c) labor. In spite of the foregoing, the meetings with Gosstroy representatives elicited statements such as: "For a typical 9-story apartment building of 530,000-710,000 ft^3, the construction time is 1 1/2 months for preparation and foundations, plus ten months for construction. A larger building with 900,000-1,400,000 ft^3 would require 2 months longer."

For a typical Leningrad large apartment building, the erection crew will have two teams of 24 men each. They work a 40-hour week. Three of the six staircases are assigned to each of the two teams. The team will be divided into 16 men on day shift, 4 men on evening shift and 4 men on night shift.

With thousands of apartment units being built to the same design, the guarantees to a prefabricating plant are substantial. Prefabrication plant scheduling of materials and production are claimed to be a year in advance. This, of course, has the same beneficial effect on the scheduling of labor and equipment at the construction sites. However, it is acknowledged that not enough storage is available so that "surge piles" can be set up to ensure continuous construction. In their zeal for the "perfect" flow of materials, the Combines have trucks, factory offices, and construction sites with radio communication, so that theoretically the trailers can be loaded at the plant with fresh production, trucked to the site immediately, and the load lifted from the truck-trailer directly to its place on the partially constructed building. At one plant the US team was shown an elaborate computerized production line-shipping-trucking-unloading plant-to-site inventory set-up which was supposed to green light (OK), yellow light (low inventory) or red light (stoppage) for every item in the chain, but it was still admittedly being debugged. All of these types of things to eliminate handling and inventory expense are worthwhile goals.

• Panel Jointing and Winter Considerations

For panel-type construction, the same types of joints used generally throughout the world are used in the USSR. The welding or bolting of steel inserts is common. Leningrad has adopted another means using a pin-and-socket joint (requiring no welding) with the void space filled with grouting. Sometimes a hairpin rod extending the height of, say, Panel A goes through the top and becomes its lifting hook which fits into a pocket cast in the lower portion of Panel B above and mates with the hairpin rod extension of Panel B. The connection can be welded or grouted, or both.

One method of tying the floor slabs to the bearing walls is to have the outer edge of the floor slab toothed, and having continuous steel reinforcement along the edge of the teeth in a horizontal plane on top of the bearing wall and then placing concrete to fill the gaps and cover the steel reinforcement.

With respect to winter construction of prefabricated housing, no enclosures are used, even in the coldest temperatures. There are a few rooms in the buidling set aside for warming the workers periodically. On grouting, either chemicals or electric resistance heaters are used to accommodate the winter weather.

• Brick Construction

One brick construction job of several 8- and 9-story apartment buildings in a Leningrad complex was observed. All apartment building complexes have nurseries, small offices, shops, restaurants and other amenities. It is intended to add more buildings which will be 12 stories high. The entire project is a 4 to 4 1/2 year construction job. It is claimed that each major unit has taken 14 months to construct, and that if the work had been of prefabricated concrete panels, it would have taken 12 months. Each one of the building units has 250 apartments. There is one bricklayer helper for every two bricklayers, and each bricklayer lays 120-150 bricks per hour - almost double the US rate.

• Box Construction

Glavkievgorstroy (Kiev City Building Committee) has experimented with the so-called box construction and has assembled two experimental apartment houses. The box is 15 ft long, 10 ft wide and 9 ft high. The government will build more of these and thinks it will be more economical than panel-type construction. The external panel is "glued" to the box. The box excludes the floor, which permits the separate floor slab to include balconies cantilevered 3 feet. The corners of the box are loadbearing. Interior walls are 2 1/2 in thick and the insulated exterior walls are 3 1/2 in thick including the insulation. The corner-loadbearing design permits large openings for both interior and exterior walls. Plans call for making the box larger - 22 ft x 11 ft x 9 ft, weighing 13 tons.

• Industrial Buildings

In addition to apartment buildings, Kiev Trust No. 1 (Brovary) erects factory buildings, half of which are one-story and roofed with a concrete shell.

1. The factories have a standard column spacing of 39 ft and maximum spacing of 59 ft. Typical spacing is 39 ft between the centerlines of the columns. There are spans of 59, 79 and 118 ft with the emphasis on 79 ft. The concrete roof planks are 10 x 39 ft. Foam insulation and one layer of roofing complete the roof.

2. The usual building is rectangular and has 16,000 ft^2 of floor area.

3. On each shift during construction there is one crane operator plus five workers. They generally work two shifts per day to erect the column,, wall, trusses and roof structure.

4. Trust No. 1 has also standardized on the design of movie houses and shops so that the trusses, panels and roof slabs are fairly standardized.

One of Kiev Trust No. 1's typical factory buildings was visited: a diamond factory with one floor for the factory proper, 8 floors for the office building and one floor for the canteen. The entire building is 350,000 ft^2. The construction labor, including the landscaping, totaled 96,000 man-hours, excluding the truck drivers. There were an average of 400 workers on the site during construction. The Trust also builds factories of 9, 12 and 16 stories.

A parking garage under construction in Kiev was visited. The capacity will be 1,200 taxicabs, plus a separate building which can accommodate 100 taxis for repair. This building uses precast beams and slabs for a total height of seven stories. There are 6 bays, each 30 ft wide. The erection crane cannot reach over one bay to the next bay, so the crane is put on rails and erects one bay on each side of the crane, and then backs up in the area between these two bays to complete what is then the middle bay. In this particular area, there were 39 ft long piles required. Construction time for this building will take two years. In the United States it would take a maximum of 10 months using the type of prefabrication by which this building is being built.

A depot (for 550 buses) under construction in Kiev was observed. This is an interesting circular building 525 ft in diameter with 84 precast columns around the periphery, spaced every 20 feet. In the center of the structure is a 55 ft high concrete column which will anchor the 84 roof-suspension cables each connected to one of the columns in the peripheral ring. The 84 columns were in place with the factory-precast concrete forms resting on top of them ready for pouring the post-tensioned reinforced concrete compression ring which will be the outside anchor for the 84 cables. Precast thin-shell reinforced concrete roof slabs will rest on the cables. Walls will be glass. A one-tenth scale model was built and tested for wind and snow loads. This building will certainly reflect creative architecture and innovative design.

- Apartment House Statistics

Various statistics on apartment sizes, building sizes, labor and material consumption and costs for construction in the major cities are presented in Schedules PDB-2 through PDB-8. Conversion factors are shown on Schedule PDB-9.

- Commentary

With respect to industrialization of construction practices generally, it is interesting to note the comments in a recent Moscow newspaper article as reported to the US team:

1. 60% of construction workers are engaged in hand labor.

2. Obsolete machinery is still being produced. For "E-652", the most widely used excavator, annual maintenance costs are twice as much as the original cost.

3. Modern machines remain on paper. The excavating machine "E-4010" was tested ten years ago, but is still not produced. The crane "K-6119" was supposed to go into production in 1965 but has still not been produced.

Nevertheless, prefabrication, which is the heart of the industrialized building process, has resulted in significant savings - 30-45% in construction time - compared with conventional construction. The combined factory and construction labor savings are claimed to be 40-50%, and from the US team's observations, this appears to be a reasonable estimate.

QUALITY AND QUALITY CONTROL

The USSR Council of Ministers has officially criticized the quality of construction. The hosts to the US team acknowledged that lack of quality in both factory products and construction was one of the most important problems facing the USSR during the next decade now that the housing crisis per se has been overcome.

One may question whether in the Soviet system there is a proper chain of command and responsibility for quality control and inspection. As best the US team could determine, there is an adequate organizational responsibility:

1. The State Committee for Civil Construction and Architecture (Gosgrazdanstroy) is a division of Gosstroy. It is responsible for overall USSR quality control, makes

spot checks at the factories and construction sites, and has the authority to stop a factory or construction project if the quality is low.

2. The City Council has local responsibility for inspection and quality control at the factories and construction sites.

3. The quality control group and inspectors in the factory report to the plant manager.

The problem may lie in the USSR's combination of "situations": (1) where sale of a product or building is guaranteed and there are no competitors, and costs will be paid, (2) where bonuses are based solely on production, (3) where the combine erects as well as fabricates (so there is no independent contractor to reject faultily fabricated material), (4) where the shortage of factory and construction workmen (let alone skilled workmen) is so acute that almost half of the workers are women, (5) where the rapid transition from a rural to an urban population, coupled with the war destruction, called for Herculean efforts to "build it now," and (6) where there have been millions of people waiting in shared apartments. The USSR has "built it now" in great quantity. People who lived in cabins or dilapidated buildings without electricity or water before the War moved into apartments, sharing bathrooms and kitchens with other families in the 1950's. Then in the 1960's, they were able to move into new apartments with their own kitchens and bathrooms. For the 1970's the effort will be to increase the apartment sizes and amenities, and, of course, the quality of construction as the workers become more skilled. Quality is a relative term and the US team's observations were made in relation to US quality. It is a fair conclusion that if the US were building its houses with as low a ratio of skilled craftsmen to million square feet of buildings as does the USSR, there would be serious quality problems in the US as well. It is only in the light of the above, with admiration for the success of the USSR in housing its population in the face of tremendous difficulties, that the observations relative to quality of materials, design and construction have been noted by the US team.

1. In the panel factories, there is evidence of significant mishandling of green panels - chipping and gouging. Inverted steel channels used as bottom supports on which the panels rest vertically often do not have the wood blocking in place, so the bottom of the panel is broken by the sharp channel edges. In some of the factories, a disproportionately large number of panels (relative to US practice) had rough or pocked surfaces.

2. A Kiev apartment house built of experimental boxes in five stories was visited. The workmanship throughout was of poor quality on the windows, doors and fixtures; water pipes were exposed. The windows were installed in the panels at the factory and somewhere in the shipping or construction process, the glass and sash were extensively damaged. One interesting point is that the combination of washbasin and bathtub has one swinging spout; when one wishes to fill the bathtub, he turns the spout that is normally facing the basin into the bathtub; the spout is 1/2 in in diameter.

3. The new Arts Palace in Tashkent was under construction. It was disconcerting to see that the finely honed granite slab floor had already been laid, even though the erection of the structure was incomplete; debris and construction materials were piled on the floor. Polished pink marble decorative slabs had been stacked among the debris and construction lumber on the floors of the unfinished building. Much of the floor was chipped and scratched, and there were many pieces of broken marble scattered about. There is no reason for this material to be near the building at this

stage of construction.

4. At almost all the construction sites visited, there appeared to be serious problems with the maintenance of window flashings, breakage of windows, damage to door trim, the necessity for multiple heavy coats of paint to cover up the defects, and missing or broken embedded tile on exterior panels.

5. On many of the panel-type buildings, the joints between interior panels were uneven and as much as two inches apart; the finish workmen were unable to patch the space properly before finish paint or wallpaper was applied.

6. The plumbing fixtures are generally of the 1920-30 vintage in the US - sinks small and shallow, toilets with inadequate venting, essentially no cabinetry or storage space.

7. The hotels, although less than three years old, have windows that don't work; bathrooms with archaic fixtures, broken floor tile, no shower curtains or doors, no basin or tub stoppers; and elevators that don't work. In one of the new hotels the hot water was shut off from 11 p.m.-6 a.m.

8. On one completed seven-story, 384-unit apartment building which is part of a complex to house 40,000 people, observations by the US team are as follows:

a. There were inadequate metal window sills which appeared to be a universal part of almost all apartment construction in the USSR. The sills were bent out of shape, and in some instances, couldn't possibly keep out the water.

b. The wood sash, hinge pinning and painting were of very poor quality.

c. There were exposed electric pullchain switches, and light sockets hanging from the ceiling.

d. There was essentially no storage or closet space in the apartments.

e. The plumbing was generally exposed throughout the apartment; the kitchen had a 10 in x 12 in sink with no counter space.

f. There was a lack of care in installing the electric switch boxes; in one instance, a box had been hammered into place with substantial damage.

g. There were no latches or locks on the bathroom and toilet doors. The tubs were on legs.

9. Apartment design philosophy has been dictated by the necessity of building square feet as rapidly as possible. Thus, the space allotted per occupant, regardless of social or economic station, is approximately the same as US HAA minimum (public housing) standards (Schedule PDB-8). Closets are almost nonexistent, the kitchen has possibly two feet of built-in sink drainboard, and another two feet of overhead cabinets, the tenant must put in his own light fixtures (only the socket is furnished with the apartment), heat is from a wall-hung metal radiator (hot water), and almost all piping is exposed. Other than statements from Gosstroy that they plan to have 15 m^2 of net living space per person by 1985 (they now have 7.4 m^2 and current building design allots 10 m^2), the US team saw no evidence nor received any statements of design changes to eliminate the foregoing deficiencies, both with respect to size and amenities.

The USSR polls its "tenants" periodically relative to apartment design, quality and amenities. A typical case in point is Leningrad. For Leningrad and the area to the north, most of the designs for large projects are done by the Leningrad Civil Engineering Institute and the site plan is prepared by the Leningrad City Council. Every year there are 100,000 families polled to get their views on the design and quality of their apartments and apartment buildings. Students do this polling during the summer vacation. The Institute prepares the questionnaire to be answered by tenants and records the results. Over a period of years, trends are observed in the needs and desires of the tenants.

The US team received different answers to the question of how often the "apartment model" is changed; a reasonable concensus is every four to ten years.

A concluding thought for this chapter on production/construction is that the concept or "process" of the industrialized building system has been well thought out in the USSR, and the "test-bed" of a regimented, huge and guaranteed market for the product is a perfect one. However, the execution from the standpoint of design flexibility, tying together the plant and construction site, and ensuring reasonable quality has not been accomplished. It is quite probable that the next ten years will see a decided improvement in these negative factors.

PART III

ECONOMICS

For the USSR, the industrialized building process is a necessary response to an economic and urban phenomenon reflecting an urgent need for mass housing - a need which can only be met by constructing large apartment building complexes. The low factory, housing and skilled labor base from which the start has been made, along with the relatively small number of skilled craftsmen required and the fact that prefabricated concrete components make it possible to construct buildings with significantly less total labor input than would otherwise be required, make industrialization the answer to the Soviets' problem. The trend of housing construction in the USSR has been impressive as to volume - it had to be with 40% of all USSR housing destroyed during World War II. Schedule PDB-1 tabulates the USSR housing construction by years. The 1968 figure of 102,100,000 m^2 of net living space is equivalent to 190,000,000 m^2 of total housing area (= 2 billion ft^2 total housing area). By comparison, the estimate for 1968 US housing construction is 1.5 billion ft^2. The USSR and the US both spent approximately 3.5% of their gross National product on housing in 1968.

The industrialized building process in the USSR consists primarily of prefabrication for housing construction, and secondarily, of prefabrication for industrial building construction - factories, public buildings and schools. The prefabricated items consist almost exclusively of precast concrete panels, boxes, trusses, beams and volumetric crosses (the latter being used primarily for earthquake resistant design). Plants for the manufacture of the precast pieces are located throughout the entire USSR. The housing segment of USSR industrialized building relates most directly to its United States counterpart and some direct economic comparisons are possible. With respect to other types of buildings, so much depends upon design and end use that a direct comparison of practices, labor costs and material costs would not be meaningful.

This chapter covers three principal items:

1. The economics of the industrialized building process within the USSR.

2. An analysis of the economics involved in using the USSR industrialized building process in the US and applying US costs to the manhours and materials consumed in the process. This cost is compared with the costs currently prevailing in the US for conventional building practices for "low-cost" apartment buildingss. It is this type of building in the US that is most nearly comparable to the USSR type, although the lowest cost apartment building in the US is superior in quality and amenities to any built in the USSR.

3. Speculation on the economics involved in using a

modified USSR (or Western European) industrialized building system in the US, taking advantage of several assumed conditions which could reduce costs and the time required to construct a building.

ECONOMICS OF THE INDUSTRIALIZED BUILDING PROCESS IN THE USSR

The USSR claims that the industrialized building process has resulted in savings of anywhere from 5-30% in construction costs as compared with conventional construction methods (brick or cast-in-situ concrete) which have little or no prefabrication. These savings come about from (1) savings in construction time and skilled labor usage, (2) the fact that construction can be performed the year around, and (3) better scheduling of delivery of materials.

Although the US team received what appeared to be conflicting information on total unit cost of building housing by the industrialized process (boxes and panels) and by the conventional process (brick or cast-in-situ concrete), the indications are that a representative figure is 25% for the unit cost spread, with boxes and panels being the lowest and brick construction being the highest unit cost. The relative proportions of labor, materials, transportation and equipment cost by type of construction are reported as follows:

	TYPE OF CONSTRUCTION		
Cost Item	Box	Panel	Brick
Labor	15	20-25*	20
Material	60	67	45
Transportation and Equipment	25	8-13	35
Total Cost	100%	100%	100%

*Split approximately 50-50 between factory/transportation and site labor.

The above numbers must be used with caution, because (1) land, amortization of fabricating plant and profit are excluded from the cost; (2) the figures for labor, materials and equipment are not always uniform among the combines and trusts because they depend on such things as whether the windows and doors are made "in-house" and whether the below-grade work is considered labor and materials or a "purchased item"; and (3) Leningrad, a major urban area, still uses brick construction.

Based upon her current experience, the USSR believes that the use of prefabricated panels, boxes and crosses (beam-type) will remain more economical than cast-in-situ concrete.

There is a preponderance of opinion that boxes will eventually be more economical than panels - up to 5-10% cheaper, but there is certainly no unanimity on this among the managers of the fabricating plants and the USSR, city and republic Gosstroys. The economical transport of prefabricated panels and boxes is limited to approximately 50 miles because of poor roads. It is reported that the only reason why all construction is not prefabricated panels, boxes, trusses and beams is that they haven't the time required to build enough fabricating plants in every city to meet the demand.

Apartment building unit construction costs are reported by the various Gosstroys as follows:

Apartment Building Costs*
Using Prefabricated Panels Unless Noted Otherwise

	Cost In Rubles Per Square Meter	
	Net Living Space**	Gross Building Area
Average for Western USSR - Actual	170	94
Goal	135	75
Leningrad - (Schedule PDB-2)	130	72
Brick, standard building	160	88
Kiev - Regular range (Schedules PDB-3, -4)	120-200	66-110
Regular average	150	83
"Economy" average (Schedule PDB-6)	118	65

*Excluding land, prefabricating plant (i.e., panels, windows, etc.) investment, interest and any heating plant, because hot water for domestic use and space heating comes from the city's central power stations which are not part of the overall building cost.

**Living room and bedrooms. For ratios to useful living area (includes kitchen, bathroom and inside hall) and gross apartment building area, see Schedule PDB-9.

In the Ukraine Republic, unit costs are claimed to be a little less than those in other parts of the USSR, but this was not confirmed. In Kiev (capital of the Ukraine), 70% of the new 9, 12, and 17-story structures are of the prefabricated, large panel type with 1, 2, 3, and 4-room apartments (See Schedules PDB-3 and -4).

In Uzbekistan (Tashkent, Samarkand) construction costs are higher due to design for high intensity earthquakes. Poor soil conditions require unusually extensive foundations, and the cost of underground work is 30% of the entire cost of the completed buildings. Schedule PDB-7 contains statistical information on the seismic design considerations, and this can be compared with the information given in Schedules PDB-3, -4, -5 and -6 which refer to areas of non-seismic design.

There are not many opportunities in the cities for apartment tenants to work on the construction of apartment buildings, otherwise known as "sweat equity." In the rural co-operatives there are some opportunities for the tenant to help with the construction.

It was interesting to note that Gosstroy representatives expressed serious concern over a decided trend toward inflation in building unit costs due to higher salaries and more amenities for the workers. In addition, the tenants were asking for more amenities which would raise costs still further.

Before comparing USSR practices with US practices and economics, one may make a rough comparison of USSR industrialized building economics with those in Western Europe where much the same "prefabrication philosophy" holds for mass housing construction.

According to the 1962 report, "The Industrial Construction of Dwellings" by E. Fouque,* (a treatise on Western European practice) a sophisticated plant and erection sequence using the prefabricated panel type of construction builds a dwelling unit of 1,050 square feet (in a large apartment building) for an average of 559 factory manhours and 613 site manhours, a total of 1,172 manhours, including direct supervision but no indirect labor. The 1962 figure of 1,172 has been reduced to 1,080 manhours in 1969; J. Hagel of the Portland Cement Association (based on his 1969 detailed

*Paper presented to the Institute of Structural Engineers, 1962.

observations of Western European plants and construction sites) suggests adding 5% to this for indirect labor, thus yielding a total of 1,130 manhours for 1,050 square feet. This figure of 1,130 equates to an average of mandays per square meter of net living space (living room and bedrooms only) for Western European practice which may be compared with the USSR average of 3.8 mandays per square meter of net living space (Schedule PDB-B) for a typical USSR 9-story apartment building. It is apparent that the Russian practice has not yet reached the degree of efficiency attained by other European countries.

One may speculate on the trend of USSR unit costs as the Soviets perfect their industrialized building system. There are pluses and minuses. On the one hand they have already reached the ultimate in favored treatment for the factories and constructors by providing:

1. guaranteed full production at a rate set a year in advance and guaranteed sale of product
2. standardization of product with significant changes no more frequently than every three years
3. year-around production and construction
4. large production plants and massive construction complexes
5. high priority by government and thus labor availability.

It is difficult to predict any future unit cost reductions with the above circumstances already prevailing. On the other hand, one sees the following "minuses" which can be overcome:

1. apparent shortages of materials (or the delivery thereof) and skilled labor, so that for every construction job actually being worked, there are at least three or four unfinished jobs standing idle for days or weeks at a time
2. the factory products are not first quality by Western

standards and thus require considerable reworking or in some cases actual scrapping of material.

As more prefabrication plants are built, undoubtedly the number of skilled production and construction workers will increase, material shortages will be overcome, and there will be a reduction in unit costs. In addition, there appears to be considerable developmental work being pursued relative to (a) lighter panels, (b) more flexible panel production plants, and (c) the use of even a greater degree of prefabrication (i.e., boxes).

But throughout the coming decade, the main problem will probably be the impatience of the apartment dwellers (and that means essentially all urbanites) to get more space and amenities - more than the 580 ft^2 that a family of four has now or the 630 ft^2 that this same family might be lucky enough to get in one of the buildings now under construction, and more than a kitchen with just a tiny sink attached to two feet of drainboard space. Changes, if they come, may be offsetting with respect to costs and may not change the unit cost of construction significantly; but they certainly will result in a significant increase in the total capital expended for construction.

In studying the economics of USSR housing, one must keep in mind that USSR housing averages about the same size as, but is of lesser design and construction quality, than that required by the US Housing Assistance Administration (HAA) minimum standards as discussed later in this report and tabulated in Schedule PDB-8. In the USSR, this "minimum treatment" is applied to all but a tiny portion of the population. There is essentially no distinction between managers, doctors, ditch diggers, professors and jackhammer operators - they live in apartments of uniform quality in a given building - the only possible difference being in the size of the apartment which is determined by the number of people in the family.

If it is assumed that in accommodating USSR tenant desires the new apartment designs will be of average US HAA maximum standards for size (40% greater than current USSR sizes) and equal them for amenities (assumed 15% improvement), and that the 1968-69 rate of apartment unit completions (2.5 million/yr) will remain constant, the capital investment for housing in the USSR would rise from 25% of the USSR's total annual capital investment to 40% of the total annual capital investment (in 1969 rubles). Even though it would take a minimum of 3 years to effect such a design change, one can question the likelihood of such an increase in capital spending being planned now or occurring later.

In spite of the foregoing, the US team was advised repeatedly that the USSR has a goal of an average of 15 m^2 of net living space per person by 1985 compared to the current figure of 7.4 square meters and a current building program which allots a little less than 10 square meters per person in the new apartments. To reach the figure of 15 square meters by 1985 with no increase in amenities would mean increasing the volume of apartment construction by 70% over current schedules, which would raise housing's share to 43% of the USSR's total annual capital investment. If amenities are added simply to meet US HAA standards, housing would require almost half of the USSR's total annual capital costs, or double its current share. To assess the likelihood of 40-50%, rather than 25% of the USSR's capital spending being devoted to housing construction, one should be mindful of:

1. The USSR has met the basic requirement of a roof, private kitchen and bathroom for almost all its citizens, and can meet this requirement for all its citizens shortly by spending at the current rate.

2. Demands for a greater supply of consumer goods are

very pressing.

3. Capital is needed in increasingly large quantities for the development of raw materials (especially oil and gas) and plants for their conversion to finished products.

4. Capital is needed for the development and conversion of raw materials for roads, pipelines, and new towns, primarily east of the Urals.

5. The continuing "space race" has caused added pressure to increase the USSR's scientific expenditures, especially as a result of the successful US landings on the moon.

6. It is unlikely that there will be any significant reduction in military expenditures.

It is unlikely, therefore, that there will be any significant change in the size of USSR apartments before 1980. There may be a few amenities added to the apartments, the cost of which will probably be offset by reductions in factory and construction labor consumed as the USSR approaches the efficiency of the Western European industrialized building process for panel and/or box construction.

ECONOMICS OF APPLYING USSR PRACTICE IN THE US

Some technically oriented visitors to the USSR have returned to the US extolling the USSR industrialized building approach particularly with respect to housing construction - and its applicability in the US to so-called HAA "public housing" buildings and FHA 221(d)(3) buildings which are among the lowest-cost US buildings, and yet are significantly superior in quality and amenities to the best USSR apartment buildings. It is, therefore, worthwhile to estimate as directly as possible the cost of using the USSR industrialized building system for apartment houses in the United States (while using US material and labor costs), and then to compare that cost with current US costs for conventional construction of these same kinds of buildings. In any consideration of using the USSR practices in the US, many assumptions have to be made relative to changes in US practice. For instance, it should be assumed that a mass market will develop for stereotyped apartments, both with respect to amenities and size (in other words, US low-income families will accept standards less than those of HAA); that the prefabricating plants will have a guaranteed market of, say, 250,000 cubic yards of concrete products per year; that the shipping distance will be within 100 miles; and that there will be no impediments to acquisition of land and its use for the purposes of large apartment complexes. The foregoing represent rather signigicant changes in US practice, but they are essential to any consideration of using USSR practices in the US.

However, as the analyses in Schedules PDB-A through -M show, the use of the USSR industrialized building system with USSR manhour and material consumption at US costs, even including all of the beneficial assumptions mentioned above, will actually result in higher unit costs than are being experienced under the admittedly unstructured conventional building practices currently prevailing in the US. This is not to say that some industrialization of the building process is not warranted in the US; it says only that it would not be economical in the US even with all of the beneficial assumptions of a controlled mass market and guaranted factory output year after year.

The above conclusion is justified in the light of the following:

1. Schedule PDB-A and its supporting Schedules PDB-B through -L show the unit cost in the US of using the USSR industrialized building system on a typical 9-story apartment building with 144 units. The data are taken directly from official USSR reports concerning several apartment buildings

completed in 1968-69. The Soviets devoted a significant amount of planning and emphasis to preparation for and construction of these buildings. The data include manhour consumption both in the factory and at the construction site as well as the quantities of materials required. The manhour and material data were figured at current US rates to arrive at a cost of \$17.70 per ft^2 for "Total US Cost of Equivalent USSR Items." These"items" exclude land, financing costs and profit since the state owns all the land, supplies the financing and allows no profit in the sense of commonly accepted US terminology.

2. Schedule PDB-M shows that US costs currently being experienced in conventional (nonindustrialized) practice for the same building as mentioned above, but with superior quality and amenities, average \$14.20 per ft^2 for "low-cost" construction and \$16.50 per ft^2 for "average" construction throughout 12 metropolitan areas of the US. These costs exclude land, financing costs and profit. The average for the entire US is approximately \$1 less than these figures. The costs for the metropolitan areas have been used for analysis herein because the most likely market for "mass housing," if it were ever to exist in the US, would be in the metropolitan areas.

3. Before comparing the cost of \$17.70 per ft^2 for USSR practices at US costs (Item 1 above) with the US conventional "low cost" practice cost of \$14.20 (Item 2 above), it is first necessary to reduce the \$14.20 to reflect the same lesser amenities as found in the very plain USSR apartments (closets, cabinets, fixtures, etc.) - a rough approximation is \$0.50 per ft^2. So the true cost of US actual conventional building practice on a typical USSR apartment would be \$13.70 per ft^2 as compared to \$17.70 ft^2 for USSR industrialized practice in the US at US costs. Most of the difference of \$4 per ft^2 is in labor input, because the types of

materials and quantities thereof were essentially the same in both analyses. Accordingly, if one were to assume that the Western European industrialized building rate of 2.6 mandays per m^2 of net living space could be attained under efficient operations in the USSR, rather than the currently claimed USSR level of 3.8 mandays per m^2, then equating the lower number of 2.6 mandays to the analysis of USSR industrialized practice at US costs would reduce the cost by \$3.20 per ft^2. Another difference is the \$0.40 per ft^2 for the panel plant (Schedule PDB-A) since this is not a part of the US nonindustrialized building practice. One further reduction would be the architect-engineer fee of 5% on the reduced labor cost if USSR practice could match Western European practice (0.05 x \$3.20) which would amount to approximately \$0.20 per ft^2. These three reductions together total \$3.80 per ft^2 and essentially account for the \$4 difference in cost between USSR practice with US costs and US conventional nonindustrialized practice.

It has been claimed recently that the cost of a USSR apartment is substantially less than that of a US apartment. Of course, one must define his terms and specifications. As noted in previous sections, USSR apartment standards generally allot less space per occupant in small families and more space per occupant in large families for all classes of tenants (regardless of income or position in the sociological structure) than do US HAA minimum standards (Schedule PDB-8) for "public housing." The weighted average for both small and large families (on a per-occupant basis) is essentially the same between the USSR and US HAA minimum standards. HAA maximum standards for apartment size are approximately 40% more than HAA minimum standards. Any discussion of USSR versus US apartment sizes and costs should be based on the following considerations:

1. The USSR has an announced goal of 15 m^2 of net

living space per person; since its new apartment buildings average 10 m^2 per person, this would mean increasing the average standard apartment size of 630 ft^2 scheduled to be built for a family of four (Schedule PDB-8), to a larger size of 930 ft^2. With respect to amenities, the USSR officials state that the tenants are asking for more than they have now in the newer buildings, but the officials are silent on how many more amenities will be allowed.

2. Because the nature of the industrialized building process tends to standardize size, design, and amenities at a relatively low level of flexibility, large-scale apartment building in the US would tend to be applicable only to subsidized housing for low-income families, thus leading to meeting current HAA standards. On HAA minimum standards, the apartment size would be 510 square feet; on HAA maximum standards, it would be 720 square feet.

Based on the foregoing, the following comparison can be made between the above items for the USSR and the United States.

	USSR	U.S.
1. USSR industrialized practice, equivalent USSR items at US cost per ft^2		\$17.70
2. US conventional practice, equivalent USSR items at US cost per ft^2		\$13.70
3. US conventional practice, HAA minimum standard items at US cost per ft^2		\$14.20
4. Family of four - apartment size		
Current building practice - ft^2	630	
Projected building practice - ft^2	950	
HAA minimum standard size - ft^2		510
HAA maximum standard size - ft^2		720

5. US cost of apartment* using the following:

USSR industrialized practice and USSR current size	$11,200
USSR industrialized practice and USSR projected size	$16,800
US convent'l practice, USSR amenities, HAA min. std. size	$ 7,000
US convent'l practice, USSR amenities, HAA max. std. size	$ 9,900
US convent'l practice and HAA min. standards	$ 7,200
US convent'l practice and HAA max. standards	$10,200

*Exclusive of proportionate share of public area of the apartment building which is the same for both USSR and US building design.

The foregoing tabulation leads to the firm conclusion that current US conventional building practice is more economical on both a unit-cost and apartment-cost basis than the industrialized practice of the USSR. This then stimulates the question "Is there any potential benefit to the US housing program (particularly low-cost housing) in using <u>any</u> industrialized building system (USSR, Western European, or US)?" The question and a possible answer are discussed next in this report.

In contrast with the analysis on housing costs, it is impossible to make a quantitative economic comparison of the USSR industrialized building practice for stores, factories and movie houses with the practice in the US, because the USSR practice is rigidly standardized (with respect both to design and to limiting material to concrete), and the US practice has essentially no standardization. Even without any significant degree of standardization, however, the US has "industrialized" its nonhousing building practices to a significant extent with the prefabrication of beams, trusses, columns and slabs out of either steel or concrete, depending on which material for a given structure is considered more economical - a choice not available in the USSR. In the USSR, prefabricated concrete trusses which appeared to the US team to have much less mass than trusses for similar use in the US were observed; further study of this is warranted. For the US to benefit economically from further industrialization of its nonhousing building practices, it would be necessary to have significantly more standardization of design of stores, factories and movie houses - a most unlikely situation; even then it is doubtful that measurable economic gains would be obtained.

EXTENSION OF THE INDUSTRIALIZED PROCESS TO US HOUSING

An analysis of the US construction industry indicates that:

1. In the last 10 years, physical output per construction worker has increased at a rate of only 0.4% per year compared with an annual productivity improvement rate of 2.5% for the total economy.*

2. Between 1945 and 1968, the homebuilding industry produced an annual average of 1.3 million dwelling units for the private market and 50,000 units of "public housing"; the industry built fewer than 2 million units in its most productive year of that period.*

3. The 1968 Housing and Urban Development Act established a 10-year goal of 26 million dwelling units, including 6 million subsidized units for low- and moderate-income families. This total of 2.6 million units per year is considered the minimum required to house the nations's population properly by 1979. With a normal curve of acceleration, the production rate must reach at least 3 million

*Reference Engineering News Record, October 30, 1969.

units per year toward the end of the 10-year period.

4. The number of skilled construction workers available for all current construction demands, industrial and nonindustrial, is too small to handle even present needs; and this is in spite of a recent history of record wages and wage increases as well as cutbacks in federal construction.

5. There is a vast untapped reservoir of unskilled labor that can be trained far more quickly for jobs in the "industrialized building process" (panel/box factories and erection/finishing) than in the conventional construction industry.

6. Current figures show that with prevailing costs of land, construction, interest and taxes, there is no chance of building a house or apartment at a cost within the means of a low-income family; and most, if not all, of the cost items are rising faster than the incomes of most low-income families.

7. Economic studies show that even with a 20% reduction in material and construction labor costs, the resultant reduction in monthly rent or purchase payments would be only 5%; the reason lies in the significant effect of interest, land, operating expense and taxes on monthly installments. Thus, any production of housing for low-income families must be subsidized, and it becomes imperative that the cost (and, therefore, the subsidy) be as low as possible.

Regarding the significant increase in housing construction called for by the 1968 Housing and Urban Development Act - there is probably insufficient skilled labor in the US to meet the time schedule of this demand unless there is a change in the building practices which currently prevail. The best chance for change is to augment the industrialized building process already underway in the US. So, if the process can come close to competing economically with current conventional building practice, the physical requirements of building 12 times as many "low cost" dwelling units per year as we do now will probably become the dominant consideration in meeting the goal. If one assumes that financing, land and subsidies are secured (and they must be, if the goal is to be met), then what about the industrialized production capability of the US?

In recent years there has been a rapid expansion of the mobile home industry (trailer homes) to produce transportable modules for permanent homes. These modules, complete with walls, floor, roof, piping, wiring and fixtures, can be used singly or in combination (on one, two or three levels), depending on the size of the home or combination of homes desired. Modules are being built in sizes up to 12 x 60 ft and are generally of wood frame (occasionally steel or aluminum frame) construction. Depending on the selling price, module size and highways, economic truck transport is possible up to 800 miles. The home owner or developer will have already bought his lot and put in foundations and steps (occasionally a basement); after arrival of the modules, a local plumber and electrician will make the necessary utility connections.

In certain areas of the US, there have been problems with local codes and with the unwillingness of some unions to connect the utilities to a module built with either nonunion labor or by "nontraditional" building unions in a factory. For single-family and low-rise buildings, the prefabricated building modules are now being sold for $7-10 per square foot at the factory and $10-12 per square foot installed, including all costs and profits but not land. With carpentry, plumbing and electrical items largely installed under continuously productive conditions at the factory, there should not be a serious labor shortage overall, even with a multifold expansion of module production capability.

Most of the current predictions are that this type of housing construction will continue to grow throughout the US as code and labor problems are solved. Accordingly, there will be continued and very rapid expansion of this process in a relatively low capital-intensive industry. This should result in a reduction of \$1 to \$2 per ft^2 in costs (1969 index) and a range of \$9-10 per ft^2 including everything except land. There are limits, however, to the application of the prefabricated module, particularly with respect to high density land use in metropolitan areas, as the present structural limit is 3-high at the above-mentioned prices. However, even with the 3-high limitation, there is still a vast, untapped market both in-city and on the fringe of the city.

For high-rise construction, which is the major potential in-city market, some form of structure with slots to house the modules or a prefabricated concrete panel or box system will be required, as there would be labor shortages in many of the construction crafts if conventional poured-in-place concrete buildings were built in sufficient quantity to accommodate the housing requirements of low-income families. With all the US's ingenuity applied to concrete panel or box prefabrication and erection for a truly large market in metropolitan areas, it is quite likely that there will be a reduction in the total unit cost of construction using this form of the industrialized building process. At present, there is very limited capacity for this kind of building in the US, mainly because it is still in the development stage, and, there has been no "market (including land) aggregation" warranting large scale operations.

An insight into the subject of cost savings resulting from the use of prefabricated concrete boxes or panels could be obtained by reanalyzing the relatively well-established

Western European systems and costs to determine their applicability in the US. This, of course, is beyond the scope of this report. However, a few observations are in order:

1. As noted, Western European practices have cut combined factory and construction labor input per ft^2 of building to 70% of that required for the USSR and can certainly cut still more.

2. Western European prefabrication plants have much lighter machinery; some plants can be moved from construction site to construction site, and many times significant portions of the plant are outdoors. These factors indicate a production plant costing less than half that of the USSR plants based on US costs.

3. Reductions in cost resulting from improvements in Items 1 and 2 could bring US costs with the box/panel system to a level competitive with current conventional US practice. The principal requirement to accomplish this is a metropolitan market which is large enough to sustain prefabrication plants with capacity of, say, 150,000-250,000 yds^3 of product per year, equivalent to approximately 4,000-7,000 dwelling units of a size averaging midway between HAA minimum and maximum standards. Additional study might indicate that smaller plants would be economical also.

4. Several of the British, French and Italian industrialized building systems are being aggressively merchandised in the US; experienced US firms have become licensees. Since these arrangements are on a strictly commercial basis, there is every reason to believe that one or more of these foreign systems and/or the US systems currently under development, will be competitive with conventional US building practices for high-rise, low-cost housing.

5. The Department of Housing and Urban Development recognized the need for studying the constraints on innovation (1) in producing by both conventional practice and the indus-

trialized process an adequate supply of housing for low-income families, and (2) in reducing current costs of housing construction. This recognition of need led to the In-Cities Experimental Housing Research and Development Project and to Operation Breakthrough currently in progress.

6. A very large proportion of the more than 600 proposals received in September, 1969, by the Department of Housing and Urban Development's Operation Breakthrough Program were based on some form of industrialized building practice, which indicates the positive thinking of US industry relative to the possibility of creating an economic breakthrough.

In summary, it appears that the only chance of meeting the requirement of housing the US population adequately by 1979 lies with the industrialization of the building process by an expansion of the prefabricated frame-type module process and the rapid implementation of the prefabricated concrete panel/box system. The module system is already competitive economically with current US conventional construction, and there is every indication that the panel/box system will be also, assuming in the latter case that there is adequate market aggregation to sustain large prefabricating plants. The Department of Housing and Urban Development has already taken the first steps leading to the development of techniques for such market (including land) aggregation as part of its Operation Breakthrough program.

Finally, the advent of industrialization of the building process in the US will undoubtedly have the beneficial effect of reducing the cost and construction time of the conventional building process by forcing on it, long-overdue changes in restrictive codes and labor practices. This indirect influence on conventional building practices may make a contribution to the US economy equal in importance to the benefits which will accrue to the economy as a direct result of the implementation of the industrialized building process by itself.

Appendix (P.D. Bush)

SCHEDULE PDB-1

USSR HOUSING PRODUCTION

MILLION SQUARE METERS NET LIVING SPACE*

	1964	1965	1966	1967	1968	Prelim. Est. 1969
GOVERNMENT & COOPERATIVE	58.9	63.2	65.9	68.7	69.3	71.8
BUILDING AT "PRIVATE" EXPENSE	16.2	16.1	15.9	15.6	14.2	
COLLECTIVE FARMS & FARMERS	17.6	18.3	20.3	20.2	18.6	31.2
TOTAL	92.7	97.6	102.1	104.5	102.1	103.0

Source: USSR Gosstroy (State Building Committee), Sept. 8, 1969

* Net living space includes living room and bedrooms and excludes inside hall, kitchen and bathroom. The ratio of an apartment's useful living space (including inside hall, kitchen and bathroom) to net living space varies from 1.3 to 2.0 and depends on the number of bedrooms; the weighted average for an apartment building of mixed units is approximately 1.45 (Schedules PDB-2, -3 and -4). The total useful living space of all the apartments in a building represents approximately 80% of the gross area of the building. The other 20% includes stairs, elevators, lobbies, garbage chutes, laundries, utility rooms and storage.

NOTE: The current goal is to provide 9 m^2 of net living space per person, but the actual average is 7.4 m^2. The current average for new construction is approximately 33 m^2 net living space per apartment for the "government" apartments. The cooperative, private and farm units are somewhat larger and may raise the average to 40 m^2 net living space per apartment. On this basis, the reported 1968 total of 102 million m^2 net living space would have yielded 2.6 million apartments which coincides closely with the 2.5 million claimed by Gosstroy.

1

SCHEDULE PDB-2

L E N I N G R A D

BASIC INFORMATION FOR TYPICAL NEW 9-STORY APARTMENT BUILDING

Source: Glavleningradstroy House Building Combine No. 2, August 29, 1969

216 APARTMENTS
6 STAIRCASES
1 ELEVATOR PER STAIRCASE
4 APARTMENTS AROUND EACH STAIRCASE

APARTMENTS	LIVING ROOMS**	PEOPLE	NET LIVING SPACE/APT.**	USEFUL LIVING SPACE/APT.***	RATIO USEFUL LIVING SPACE/ NET LIVING SPACE
10-12% - 24	1	1-2	16 m^2	32 m^2 = 350 ft^2	2.0
30% - 65	2	3	28-30	48-50 = 530	1.7
48% - 103	3	4-5*	45	64 = 690	1.4
10-12% - 24	4	5-6*	55	72 = 780	1.3
100% - 216	2.6	3.7	38.2	56.9 612	1.49****

* Occasionally

** Includes living room and bedrooms, and excludes inside hall, kitchen and bathroom.

*** Living room, bedrooms, inside hall, kitchen, bathroom. The total useful living space of all the apartments in the building represents approximately 80% of the gross area of the building. The other 20% includes stairs, elevators, lobbies, garbage chutes, laundries, utility rooms, and storage.

**** Weighted average

NOTE: Hot water is piped from one of several city central station power plants (back pressure turbines) for use by apartment building for space heating (radiators in apartments) and normal hot water consumption.

2

SCHEDULE PDB-3

KIEV

BASIC INFORMATION FOR TYPICAL NEW 9-STORY APARTMENT BUILDING

PANEL CONSTRUCTION - 53 UNITS/BUILDING

Source: Glavkievgorstroy and House Building Combine No. 3, Sept. 1, 1969

A. Glavkievgorstroy House Building Combine No. 3 Typical Building

53 Apartment units per apartment building
1667 m^2 net living space; ave. = 31.5 m^2/apt. (living room and bedrooms; excludes inside hall, kitchen and bathroom)
2389 m^2 useful living space; ave. = 45.0 m^2/apt.*
Ratio useful living space/net living space = 1.43

*Living room, bedrooms, inside hall, kitchen and bathroom. The total useful living space of all the apartments in the building represents approximately 80% of the gross area of the building. The other 20% includes stairs, elevators, lobbies, garbage chutes, laundries, utility rooms and storage.

B. General Information

One elevator for each of the 3 sets of stairs = 3 elevators. If 17-story building, 2 elevators for each set of 3 stairs = 6 elevators

Panel plant averages 144 m^3 finished panels/man-yr (includes total plant personnel)

Panel plant averages 97.5% yield concrete shipped/made

Panel plant largest panel = 6.5 x 6.5 meters
interior panel = 3.2 x 6.5 meters

Erection Crane = 0.03 man-day/m^2 useful living space (9 stories)
0.02 " " " " " " (5 stories)

1 operator/crane gets 5 rubles/day
Rental (including operator) = 15 rubles/day - 1st shift
10 " " - 2nd shift
0 " " - 3rd shift

Transport = 4 kopeks/M.T.- km travel M.T. = metric ton
2 " " " load and unloading
6 " " " total

1 tractor handles 3 trailers

Truck rental = 18-20 rubles/day including operator who gets 6 rubles/day

3

SCHEDULE PDB-3 (CONT'D)

K I E V

Windows (installed at site)

30	Rubles equipment cost	to	install	100 m^2	double	windows
120	Rubles labor cost*	"	"	"	"	"
39	Man-hours labor*	"	"	"	"	"
25	Rubles equipment cost	"	"	100 m^2	single	windows
70	Rubles labor cost*	"	"	"	"	"
24	Man-hours labor*	"	"	"	"	"

* These numbers indicate approximately 3 rubles/man-hour which would be equivalent to 24 rubles/day which is not correct, as the more probable number is 6 - 7 rubles/day. This information was not used in any of the analyses.

Combine No. 3 will build 4,000 apartments in 1969. 2,200 workers (incl. Director) produce 70 m^2 net living space/man-yr; the labor distribution is approximately 50% at plant and 50% at site. These numbers exclude the labor from the Trusts which do the below-grade, plumbing, electrical and certain other specialty trades.

Summary of Total Labor Consumption - Combines and Trusts

Panel factory and transport labor	1.7	man-days/m^2 net living space
Site labor	1.8	" " " " "
Total Labor	3.5	man-days/m^2 net living space

Details of Labor Consumption

		Man-days/m^2 Net Living Space	
Panel fabrication at factory		1.500	
Transport		0.200	
Subtotal Factory & Transport		1.700	Say 1.7
Below grade	0.12-0.15	0.13	
Erection		0.40	
Plumbing		0.20	
Elec./commun.		0.10	
Crane operation		0.05	
Elevator installation		0.005	
Finishing		0.90	
Miscellaneous		0.004	
Clerk of works		0.028	
Superintendent's staff		0.008	
Subtotal Site		1.825	Say 1.8
Total Labor			3.5

4

SCHEDULE PDB-3 (CONT'D)

KIEV

Based on an extension of some of the above numbers (i.e. for elevator installation, crane operation and superintendent's staff) to man-days for the job, it is evident that the numbers are too low and thus, the totals are low. The total of 1.825 site labor man-days per m^2 of net living space should be compared with the published figures on Schedules 4 and 5.

Cost of materials and labor (excl. district communication lines and landscaping) = 120 rubles/m^2 net living space

Steel consumption above grade (reinforcing, rails, garbage chutes, dowels, splices, etc.) = 33 kg/m^2 net living space, of which 25 kg/m^2 (per Moscow Structural Design Institute, Sept. 8, 1969) is reinforcing steel in concrete above grade and 8 kg/m^2 (Schedule 4) is all steel excluding reinforcing. No figure was obtained for reinforcing steel in concrete below grade; U. S. practice for non-seismic areas equated to "net living space" concept is 3 kg/m^2 for this component, and this number will be used in preparing material and cost estimates.

Hot water is piped from one of several city central station power plants (back pressure turbines) for use by the apartment building for space heating (radiators in apartments) and normal hot water consumption.

5

SCHEDULE PDB-4

K I E V

BASIC INFORMATION FOR TYPICAL NEW 9-STORY APARTMENT BUILDING

PANEL CONSTRUCTION - 144 UNITS/BUILDING

Source: Glavkievgorstroy Headquarters, Sept. 1-3, 1969, and
Report "Rapid Construction of Apartment Houses In The Ukrainian SSR" by Gosstroy Ukr SSr, Scientific-Research Institute of the Construction Industry, Kiev, 1969

A. General Information

144 apartment units per apartment building (Bereznyaki)
5,080 m^2 net living space; ave. = 35.3 m^2/apt. (living room and bedrooms; excludes inside hall, kitchen and bathroom)
7,222 m^2 useful living space; ave. = 50.3 m^2/apt.*
Ratio useful living space/net living space = 1.42

* Living room, bedrooms, inside hall, kitchen and bathroom. The total useful living space of all the apartments in the building represents approximately 80% of the gross area of the building. The other 20% includes stairs, elevators, lobbies, garbage chutes, laundries, utility rooms and storage.

Site area (floor profile)	1,052 m^2
Volume above ground	26,182 m^3
Volume below grade	255 m^3
Total volume	26,437 m^3

Apartments	No.	%	Probable Net Living Space*		Probable Useful Living Space**	
			Unit	Total	Unit	Total
One-room	18	12.5	16 m^2	290 m^2	32 m^2	580 m^2
Two-room	36	25.0	27	970	41	1,480
Three-room	72	50.0	41	2,940	56	4,032
Four-room	18	12.5	49	880	63	1,130
Total	144	100.0	35.3	5,080 m^2	50.3 m^2	7,222 m^2

* These individual apartment sizes average 8% less than those in Schedule 2
** " " " " " 12% " " " " " "

6

SCHEDULE PDB-4 (CONT'D)

KIEV

B. Material Information

Number of elevators = 4; capacity/elevator = 350 kg
Concrete below grade = 356 m^3 reinforced concrete plus 148 m^3 plain concrete
Concrete above grade** = 1415 m^3 " " " 2203 m^3 " "

** Exterior wall panels are considered plain concrete which is light weight and lightly reinforced.

Tons steel*** outside of reinforcing in concrete = 37.8 metric tons = 7.5 kg/m^2 net living space = 5.2 kg/m^2 useful living space

*** rails, balconies, garbage chutes, dowels, splices, etc.

Walls papered	27,535 m^2	
Walls painted	5,140 m^2	
Ceilings whitewashed	7,320 m^2	
Roofing	1,299 m^2	
Gypsum partitions	6,971 m^2	
Windows	776 m^2	Installation 16.6 m-hrs/100 m^2
Doors	2,238 m^2	
Radiators	832 m^2	
Wages - erection crew	7-8 rubles/day	
painters	6.5-7.5 " "	
floor men	7-8 rubles/day	

C. Site Labor Consumption

Above ground labor = 2.09 man-days/m^2 net living space

Note: To this must be added below grade labor, which according to Schedules 3 and 5 would average 0.14 man-day/m^2 net living space. An idea of the improvement reported by the figure of 2.09 man-days/m^2 is indicated by comparison with another reported figure of 2.73 experienced by the same Combine for the same types of buildings constructed during 1968.

SCHEDULE PDB-5

UKRAINIAN S S R

INFORMATION ON 5-STORY APARTMENT BUILDINGS

PANEL CONSTRUCTION

Source: Report "Rapid Construction of Apartment Houses In The Ukrainian SSR" by Gosstroy Ukr SSR, Scientific-Research Institute of the Construction Industry, Kiev, 1969

Characteristic	Apartment Buildings Donets No. 6	Donets No. 4	Makeevzhilstroy No. 12
No. of floors	5	5	5
No. of sections	4	4	6
Net living space, m^2	1,839	1,851	3,800
Volume of structure, m^3	9,203	11,013	19,000
No. of apartments	58	60	120
m^2 net living space/apt.	31.7	30.8	31.7
Construction time			
Below grade - days	16	26	13
Above ground - days	54	64	45
Total Working Days	70	90	58
Site labor, man-days/m^2 net living space			
Below grade	0.14	0.17	0.13
Erection	0.35	0.30	0.30
Finishing	1.87	1.70	1.54
Total	2.36	2.17	1.97
Yearly output of one tower crane - m^2 net living space	17,600	24,200	15,422

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SCHEDULE PDB-6

K I E V

BUILDING CONSTRUCTION FOR CHEAPEST APARTMENTS

Source: Ukraine Republic Gosstroy, September 1, 1969

	CHEAPEST APARTMENTS				UNIT COST RUBLES PER m^2
LIVING ROOMS*	PEOPLE	TOTAL COST	USEFUL LIVING SPACE***		USEFUL LIVING SPACE***
1	2	2500 Rubles	30 m^2	320 ft^2	83
2	3	3500	44	480	80
3	4-5**	4500	55	600	82
4	5-6**	5500	70	760	79

* Bedrooms and living room; excludes inside hall, kitchen and bathroom
** Occasionally
*** Living room, bedrooms, inside hall, kitchen and bathroom. The total useful living space of all the apartments in the building represents approximately 80% of the gross area of the building. The other 20% includes stairs, elevators, lobbies, garbage chutes, laundries, utility rooms and storage.

The weighted average cost is 77 rubles/m^2 useful living space according to Ukraine Republic Gosstroy. But the table above shows that it is slightly higher, as the lowest unit cost is 79 rubles/m^2. If one applies the same distribution of "various size" apartments shown in Schedule 2 for Leningrad, the table above averages 81 rubles/m^2 useful living space. This figure of 81 for the "cheapest apartments" compares favorably with the average of 100 rubles/m^2 useful living space for all apartments cited by Glavkievgorstroy (the principal municipal building ministry in the Ukraine Republic) as noted below.

Glavkievgorstroy says the range for all apartments (not only the "cheapest" ones) is 120-200 rubles/m^2 net living space with weighted average at 150-160 rubles/m^2 net living space. This equates to approximately 100 rubles/m^2 useful living space based on a ratio of 1.5 useful living space/net living space.

SCHEDULE PDB-7

T A S H K E N T

BASIC INFORMATION FOR TYPICAL NEW 4-STORY APARTMENT BUILDING CONSTRUCTION IN INTENSIVE SEISMIC ZONE

Source: Uzbek Republic Gosstroy and Glavtashkentstroy, Sept. 4-5, 1969

48 Apartment units per apartment building (no elevators)
1481 m^2 net living space; ave. = 30.9 m^2/apt. (living room and bedrooms; excludes inside hall, kitchen and bathroom)
2030 m^2 useful living space; ave. = 42.3 m^2/apt.*
Ratio useful living space/living space = 1.37

* Living room, bedrooms, inside hall, kitchen and bathroom. The total useful living space of all the apartments in the building represents approximately 80% of the gross area of the building. The other 20% includes stairs, elevators, lobbies, garbage chutes, laundries, utility rooms and storage.

64 metric tons steel in concrete above grade for Seismic Scale Intensity 8
119 metric tons " " " " " " Seismic Scale Intensity 9**
40% more panel fab-plant labor for Seismic Scale Intensity 9 vs. Moscow (non-seismic)
24% more panel " " " Seismic Scale Intensity 9 vs. Seismic Scale Intensity 8

** Seismic Scale Intensity (hereinafter referred to as "Seismic") 9 approximately equivalent to Richter 12.

DSK-1 Plant Dept. 1 (built 1959) produces panels at rate of 205,000 m^2 net living space/yr.
Dept. 2 (built 1969) no production yet.

0.8 m^3 concrete/m^2 net living space above grade for Seismic 8
1.0 m^3 concrete/m^2 net living space above grade for Seismic 9
1,935 workers in panel plant produce an average of 110 m^3 concrete panels/man-yr.

110/0.8 = 140 m^2 net living space/man-yr.
140/234 = 0.60 m^2 net living space/man-day

Exterior panels = 3.2 x 6 meters x 12 cm. = 5.2 tons
Crane requirements for erection of 96 apartments = 45 days at 2 shifts/day
Crane operator wages = 125-150 rubles/month (35-hr. week)
Crane rental (incl. operator) = 16 rubles/day - 1st shift
11.2 " " - 2nd shift
Negotiating - 3rd shift

Panel factory and transport labor	1.61	man-days/m^2 net living space
Site labor	2.09	" " " "
Total Labor	3.70	man-days/m^2 net living space

Total labor for brick-type construction = 5.20 man-days/m^2 net living space

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SCHEDULE PDB-7 (CONT'D)

TASHKENT

Trucking cost = 5 kopecks/metric ton-km (average haul 10-12 km)
Hauling is 3% of total building cost
Cost of loading at panel plant for 48 apartments = 1800 rubles

Cost of 48 apartments with 1481 m^2 net living space (2030 m^2 useful living space):

	RUBLES	%	MAN-DAYS/m^2 NET LIVING SPACE
Below Grade	19,200	12.5	0.30
Erection	73,000	47.7	0.58
Plumbing	13,900	9.1	0.23
Electrical	4,700	3.1	0.20
Communications	1,000	0.7	0.06
Finishing	41,200	26.9	0.72
Sub-Total	153,000	100.0	2.09
Panel Fabrication/Transport			1.61
TOTAL FOR SEISMIC 9 (approx. equiv. Richter 12)			3.70

153,000/1481 = 103 rubles/m^2 net living space
153,000/2030 = 75 rubles/m^2 useful living space

Fabrication Plant DSK-1 capacity:

300,000 m^2 net living space/yr. = 240,000-300,000 m^3 panels/yr. depending on Seismic 8 or 9

Fabrication Plant DSK-2 capacity:

200,000 m^2 net living space/yr. = 160,000-200,000 m^3 panels/yr. depending on Seismic 8 or 9

Panels fabricated: floor = 7 x 3.8 meters x 14 cm.
external wall = 7 x 3.8 meters x 25 cm.
interior load-bearing wall = 7 x 3.8 meters x 48 cm.

For Seismic 9: 162 Apartments built in 260 working days (5-day week)
5400 m^3 concrete above grade (1.1 m^3/m^2 net living space)
4200 m^3 concrete below grade (high a/c sedimentary soil)
Net living space -- 4900 m^2 = 30.2 m^2 per apartment

Hot water is piped from one of several city central station power plants (back pressure turbines) for use by apartment building for space heating (radiators in apartments) and normal hot water consumption.

SCHEDULE PDB-7 (CONT'D)

TASHKENT

In the USSR, Seismic Scale Intensity 7, 8 and 9 are approximately equivalent to Mercali Scale 7, 8 and 9. Intensity 9 is approximately equivalent to Richter 12.

With respect to foundation concrete:

a. For buildings of no more than five stories there is no change required in the amount of reinforcing steel used for various seismic zones as compared with nonseismic zones.

b. For buildings above five stories, the USSR design adds 10% more steel for Intensity 6 relative to Intensity 5, 20% more the Intensity 7 relative to Intensity 5, and 50% more for Intensities 8 and 9 relative to Intensity 5. As a general rule for designing above Intensity 9, USSR design adds 50% more steel for the intensities above Intensity 9 to that required for Intensity 9.

With respect to the amount of steel reinforcing in concrete panel-type construction above grade:

a. Moscow is a nonseismic zone and requires 25 kg steel/m^2 net living space. This amount is used through Intensity 6.

b. For each number on the seismic scale above Intensity 6, add 10-15 kg steel/m^2 net living space for houses up to five stories.

c. In Sochi (the Crimea earthquake zone) the design for Intensity 7 uses 35 kg steel/m^2 net living space, and the design for Intensity 8 uses 45-50 kg steel/m^2 net living space.

As a general rule, each unit of intensity (i.e. 8 vs. 7) costs an extra 4-5% in overall construction cost.

SCHEDULE PDB-8

COMPARISON OF SOVIET UNION & U. S. HAA (PUBLIC HOUSING) APARTMENT SIZES & OCCUPANCIES

Soviet Union Apartment Sizes[1]				United States Apartment Sizes - HAA Public Housing Standards[5]					
		Useful Living Space[4]				Useful Living Space[4]			
						Minimum		Maximum	
Living[2] Rooms	Occupants	Sq. Ft.	Sq. Ft./Occ't	Equiv. U.S. Unit	Occupants	Sq. Ft.	Sq. Ft./Occ't	Sq. Ft.	Sq. Ft./Occ't
1	1 - 2	350	230	Efficiency	1 - 2[3]	280	280	400	400
2	3	480	160	1 bedroom	2	385	190	550	280
3	4 - 5[3]	630	160	2 bedroom	3 - 4	510	150	720	210
4	5 - 6[3]	730	150	3 bedroom	5 - 6	655	120	900	160

NOTES:

(1) Current Leningrad and Moscow standards. However, it appears that actual sizes are approximately 10% less than this.

(2) Includes living room and bedrooms; excludes interior halls, kitchen, bathroom, and storage areas.

(3) Occasionally; area per person calculated using lower number of occupants. Where this superscript is not used, the area per person is calculated using the midpoint of the number of occupants shown.

(4) Total area of apartment; USSR average from Schedules PDB-2, -4, -6.

(5) FHA areas are 5 - 10% greater, depending on unit.

SCHEDULE PDB-9

CONVERSION FACTORS

1 ft	=	0.305 m	=	30.48 cm		
1 m	=	39.4 in	=	3.28 ft	=	1.1 yd
1 cm	=	0.39 in	=	0.033 ft	=	0.011 yd
1 m^2	=	10.8 ft^2	=	1.20 yd^2		
1 ft^2	=	0.09 m^2	=	0.11 yd^2		
1 yd^2	=	0.84 m^2	=	9.0 ft^2		
1 m^3	=	35.3 ft^3	=	1.31 yd^3		
1 yd^3	=	27.0 ft^3	=	0.76 m^3		

1 hectare = 2.5 acres = 10,000 m^2

1 ruble = $1.10

LIVING AREAS

a. Net living space = area of living room and bedrooms

b. Useful living space = net living space plus inside hall, kitchen and bathroom

c. Ratio b/a varies from 1.3 to 2.0 depending on the size of the apartment; the weighted average is approximately 1.45. (Schedules PDB-2, -3, -4)

d. It is estimated that the area for lobbies, elevators, stairs, laundries, utility rooms, storage, and garbage chutes occupies 20% of the gross area of the apartment building. On this basis, the various areas are as follows:

Net living space	1.00	55.2% of gross area
Inside hall, kitchen, bathroom	0.45	24.8
Sub-Total Useful Living Space	1.45	80.0
Lobbies, elevators, stairs, etc.	0.36	20.0
Gross Area	1.81	100.0%

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SCHEDULE PDB-A

SUMMARY OF COSTS

TYPICAL USSR 9-STORY APARTMENT BUILDING BUILT IN U.S.
USING USSR INDUSTRIALIZED PROCESS (PANELS), LABOR AND MATERIAL INPUT
AT U. S. PRICES - 144 UNITS & 97,000 FT^2 GROSS BUILDING AREA

Reference Schedule	Cost Items	Cost	Cost Per Unit	Cost per Ft^2
PDB-B	Factory and Site Labor	$ 892,000	$ 6,190	$ 9.20
-C	Material			
	Architectural and Structural	387,000	2,690	4.00
-D	Plumbing and Heating	132,000	920	1.30
-E	Electrical	19,000	130	0.20
	Subtotal - Materials	$ 538,000	$ 3,740	$ 5.50
-F	Equipment Rental	68,000	470	0.70
-G	Supplemental Construction Cost	56,000	390	0.60
-H	Panel Plant (excl. labor & material)	41,000	280	0.40
-I	Landscaping and Walks	20,000	140	0.20
-I	Parking*	18,000	130	0.20
	Architect-Engineer Fee @ 5%**	82,000	570	0.90
	Total U.S. Cost-Equiv. USSR Items	$1,715,000	$11,910	$17.70
-J	Land	240,000	1,670	2.50
-K	Financing	240,000	1,670	2.50
	Total U.S. Cost Before Profit	$2,195,000	$15,250	$22.70
	Profit at 5%	110,000	750	1.10
	Total U.S. Cost	$2,304,000	$16,000	$23.80

* While parking areas are not part of USSR requirements, they are included herein for comparison of costs in this schedule with those of Schedule PDB-M (Costs for Conventional U. S. Practice) which include the cost of parking areas which are required in the U. S.

** Drawings and specifications are prepared and limited factory/site inspection is performed by the State (USSR), Republic or City Building Administration and are in addition to the above categories of charges. They are included herein at U.S. rates so that the "Total U.S. Cost-Equivalent USSR Items" will reflect a meaningful comparison with U.S. practice (i.e. Schedule PDB-M).

SCHEDULE PDB-B

LABOR COST - FACTORY, TRANSPORT AND SITE

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS & 97,000 FT^2 GROSS BUILDING AREA

LABOR CATEGORY	MAN-DAYS/m^2 NET LIVING SPACE*	TOTAL MAN-DAYS/BLDG**	AVERAGE LABOR RATE ($/HR)***	AVERAGE LABOR RATE ($/DAY)	LABOR COST PER BLDG. ($)
Factory Panel Fabrication Labor	1.50	7,620	4.95	39.60	302,000
Transport Labor	0.20	1,020	5.00	40.00	41,000
Site Construction Labor	2.11	10,720	6.40	51.20	549,000
TOTAL	3.81	19,360	5.75	46.00	892,000

Labor Cost Per Unit (144 Units) $6,190

Labor Cost Per Ft^2 (97,000 Ft^2) $9.20

* These are the basic USSR Man-days expended for a similar building. Reference Schedules PDB-3, -4, -5 and -L

** As per Schedule PDB-4, building has 5,080 m^2 net living space. This equates to 9,030 m^2 gross building area = 97,000 ft^2.

*** Reference Schedule PDB-L.

SCHEDULE PDB-C

MATERIAL COSTS - ARCHITECTURAL AND STRUCTURAL

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS & 97,000 FT^2 GROSS BUILDING AREA

ARCHITECTURAL & STRUCTURAL MATERIAL	QUANTITY (METRIC)*	U. S. COSTS QUANTITY (U.S. EQUIVALENT)	UNIT COST ($)	TOTAL COST ($)
Wallpapered Surface	27,535 m^2	296,400 Ft^2	0.08	23,700
Painted Surface	5,140 m^2	55,300 Ft^2	0.04	2,200
Whitewashed Surface (Ceilings)	7,320 m^2	78,800 Ft^2	0.01	800
Roofing, Insulation, and Sheet Metal	1,299 m^2	14,000 Ft^2	0.40	5,600
Gypsum Concrete Partitions	6,971 m^2	75,000 Ft^2	0.40	30,000
Windows (including Glass)	776 m^2	8,350 Ft^2	3.	25,000
Doors, Trim and Finish Hardware	2,238 m^2	24,100 Ft^2	2.	48,200
Concrete Above Grade - Panels, Slabs, Stairs	3,618 m^3	4,733 Yd^3	12.30**	58,200
Reinforcing Steel in Concrete Above Grade	127,000 kg	280,000 Lbs	0.08	22,400
Concrete Below Grade	504 m^3	660 Yd^3	12.30**	8,100
Reinforcing Steel in Concrete Below Grade	15,000 kg	33,000 Lbs	0.08	2,600
Miscellaneous Steel (Rails, Balconies, Chutes, etc.)	37.8 Tons	41.7 Tons	700.	29,200
Elevators - Capacity 350 kg (770 lbs.)	4 Each	4 Each	10,000.	40,000
Floor Finishes (Wood, Parquet, Linoleum, Tile)	8,800 m^2	95,000 Ft^2	0.40	38,000
Tile on Exterior Walls	3,158 m^2	34,000 Ft^2	0.60	20,400
Cabinets - Counter Type	88 m	288 LF	28.	8,100
Cabinets - Overhead	132 m	432 LF	15.	6,500
Miscellaneous Supplies (5%)				18,000
TOTAL MATERIALS COST - ARCHITECTURAL AND STRUCTURAL				$387,000

Materials (A&S) Cost Per Unit
(144 units) = $2,690

Materials (A&S) Cost Per Ft^2
(97,000 Ft^2) = $4.00

* Reference Schedule PDB-4
** Excluding reinforcing steel

SCHEDULE PDB-D

MATERIAL COSTS - PLUMBING AND HEATING

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS

AND 97,000 FT^2 GROSS BUILDING AREA

PLUMBING/HEATING MATERIAL	QUANTITY (Metric)	U.S. COSTS QUANTITY (U.S. Equivalent)	UNIT COST ($)	TOTAL COST ($)
Bathtubs	144 Ea	144 Ea	42	6,000
Lavatories	144 Ea	144 Ea	23	3,300
Toilets	144 Ea	144 Ea	32	4,600
Kitchen Sinks	144 Ea	144 Ea	18	2,600
Piping (Plumbing)	4,400 M	14,500 LF	3	44,600
Radiators	832 M^2	8,952 Ft^2	0.76	6,800
Pumps	19 Ea	19 Ea	110	2,100
Piping (Heating)	6,400 M	21,000 LF	1.13	23,800
Instrumentation	LOT	LOT	7,500	7,500
Insulation	7,080 M	23,220 LF	0.73	16,900
Furnace*	1 Ea	1 Ea	10,000	10,000
Misc. Supplies (3%)				3,800
Total Materials Cost - Plumbing and Heating				$132,000
Materials Cost - Plumbing and Heating Per Unit (144 Units)				$ 920
Materials Cost - Plumbing and Heating Per Ft^2 (97,000 Ft^2)				$ 1.30

*In USSR heat and domestic hot water are furnished by piping hot water from a municipal power plant, but this is not available in the U.S., and a furnace would be installed.

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SCHEDULE PDB-E

MATERIAL COSTS - ELECTRICAL

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS

AND 97,000 FT^2 GROSS BUILDING AREA

ELECTRICAL MATERIAL	QUANTITY (Metric)	U.S. COSTS QUANTITY (U.S. Equivalent)	UNIT COST ($)	TOTAL COST ($)
Switches	880 Ea	880 Ea	0.70	600
Receptacles	1,744 Ea	1,744 Ea	0.90	1,600
Ceiling Fixtures	880 Ea	880 Ea	3	2,600
Wire	41,200 M	135,000 LF	0.03	4,000
Switchgear and Panels	36 Ea	36 Ea	170	6,100
Distribution Feeders	4 Ea	4 Ea	800	3,200
Power Feeds (Elevators - Pumps)	8 Ea	8 Ea	50	400
Misc. Supplies (3%)				500
Total Materials Cost - Electrical				$19,000
Materials Cost - Electrical Per Unit (144 Units)				$ 130
Materials Cost - Electrical Per Ft^2 (97,000 Ft^2)				$ 0.20

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SCHEDULE PDB-F

EQUIPMENT RENTAL COSTS

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS

AND 97,000 FT^2 GROSS BUILDING AREA

EQUIPMENT RENTED	QUANTITY	RENTAL PERIOD (Months)	U.S. COSTS RATE* ($/Month)	TOTAL COST ($)
Tower Cranes (5 Ton - 70' Boom)	2	2	1,450	5,800
Tractor and 20 Ton Semitrailer	2	2	2,860	11,400
Semitrailer Only	2	2	2,140	8,600
Front End Loader (2 CY)	1	2	1,800	3,600
Dump Trucks	2	1	850	1,700
Welding Machines	4	6	200	4,800
Air Compressors	2	6	400	4,800
Hand Tools	-	9	1,000	9,000
Scaffolding	2	9	250	4,500
Skip Hoists	2	9	300	5,400
Pickup Trucks	3	12	150	5,400
Miscellaneous Allowance				3,000
Total Equipment Rental Cost				$68,000
Equipment Rental Cost Per Unit (144 Units)				$ 470
Equipment Rental Cost Per Ft^2 (97,000 Ft^2)				$ 0.70

*Estimated rates at 85% of Associated Equipment Distributors (AED) rates, excluding labor, plus allowance for fuel and maintenance supplies. Labor costs are part of overall labor cost in Schedule PDB-B.

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SCHEDULE PDB-G

SUPPLEMENTAL CONSTRUCTION COSTS

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS

AND 97,000 FT^2 GROSS BUILDING AREA

1. Shift Differential - Allowance $ 5,000

2. Spot Overtime - Premium @ 3% of Man-hours 8,000

3. Subcontractors' Overhead @ 15% of Subcontractors' Labor & Materials Costs

Subcontractors	Labor Cost*	Material Cost**	Total
Below Grade	$ 35,100	$ 10,700	$ 45,800
Plumbing/Heating	61,000	132,000	193,000
Electrical	28,400	19,000	47,400
Total	$124,500	$161,700	$286,200

0.15 x $286,200 43,000

4. Total Supplemental Construction Cost $56,000

5. Supplemental Cost Per Unit (144 Units) = $ 390

6. Supplemental Cost Per Ft^2 (97,000 Ft^2) = $ 0.60

*Reference Schedule PDB-L, labor costs per square meter net living space multiplied by 5,080 m^2 net living space.

**Reference Schedule PDB-C for below grade concrete and reinforcing steel; Schedule PDB-D for plumbing/heating cost; Schedule PDB-E for electrical cost.

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SCHEDULE PDB-H

PANEL PLANT ANNUAL COSTS

EXCLUDING LABOR AND PRODUCTION MATERIALS*

1. Investment required to produce 1,000 yd^3 of concrete per day (250,000 yd^3/yr, enough for approximately 7,500 apartment units per year)

a.	Equipment	$ 5,290,000
b.	Structures and Foundations	5,510,000
c.	Land	500,000
	Total Cost	$11,300,000

2. Annual Costs

a.	Depreciation Expense - Equipment (15 years)	$ 350,000
b.	Depreciation Expense - Structure (25 years)	220,000
c.	Maintenance and Repair Materials ($1.50/$yd^3$)	380,000
d.	Utilities and Fuel ($1.25/$yd^3$)	320,000
e.	Interest at 10% (Average per year)	570,000
f.	Taxes ($2.50/$100 of total cost)	280,000
g.	Insurance	50,000
	Total	$2,170,000

3. Cost per cubic yard of panels produced
   $2,170,000/250,000 yd^3/yr = $8.70/$yd^3$

4. Concrete panels, slabs, stairs per apartment building
   4,733 yd^3 panels (Schedule PDB-C)
   $8.70 x 4,733 = $41,000

5. Concrete cost per apartment (144 units in building - Schedule PDB-C)
   $41,000/144 = $280

6. Concrete cost per Ft^2 of apartment building (97,000 Ft^2 - Schedule PDB-C)
   $41,000/97,000 = $0.40

* The application of these costs to the typical 9-story apartment building is shown in Schedules PDB-B (Factory Panel Fabrication Labor) and PDB-C (Concrete Above Grade and Reinforcing Steel in Concrete Above Grade).

SCHEDULE PDB-H (CONT'D)

SUMMARY ESTIMATE OF CAPITAL COST

USSR-DESIGNED CONCRETE PANEL PRECASTING PLANT BUILT IN U.S.

CAPACITY - 1,000 YD^3/DAY, 250,000 YD^3/YEAR

DIRECT CONSTRUCTION COST		$6,710,000	
CONTRACTORS' OVERHEAD & PROFIT AT 15%		1,010,000	
TOTAL ESTIMATED CONSTRUCTION COST			$ 7,720,000
ENGINEERING (12 mos.) - 8% OF CONSTRUCTION COST			620,000
INTEREST DURING CONSTRUCTION (8%, 1.5 YRS)			
$\frac{0.08 \times \$7,720,000 \times 1.5}{2} =$			460,000
INTEREST ON ENGINEERING COST			
$\frac{0.08 \times \$620,000}{2} + (0.08 \times \$620,000 \times 1.5) =$			100,000
SUBTOTAL			$ 8,900,000
START-UP COSTS			
Allow 100 man-months at $1,000/man-month			100,000
TOTAL BEFORE CONTINGENCY AND LAND			$ 9,000,000
CONTINGENCY ALLOWANCE - 20%			1,800,000
TOTAL ESTIMATED COST (excluding Land)			$10,800,000
LAND COST			
Assume level, well-drained site that does not require pile foundations	17 acres	$30,000	500,000
GRAND TOTAL			$11,300,000

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SCHEDULE PDB-I

LANDSCAPING, WALKS AND PARKING

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS & 97,000 FT^2 GROSS BUILDING AREA

A.	Landscaping and Walks	$20,000
	Cost Per Unit (144 Units)	$ 140
	Cost Per Ft^2 Building (97,000 Ft^2)	$ 0.20
B.	Parking 36,000 Ft^2 at $0.50	$18,000
	Cost Per Unit (144 Units)	$ 130
	Cost Per Ft^2 Building (97,000 Ft^2)	$ 0.20

SCHEDULE PDB-J

LAND COST

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS & 97,000 FT^2 GROSS BUILDING AREA

1.	Building Area - 1,052 m^2 (Schedule PDB-4)	11,300 Ft^2
2.	Walks and green areas	11,700 Ft^2
3.	Parking Area (1 Parking Place Per Unit)	36,000 Ft^2
4.	Total Area	59,000 Ft^2
5.	Typical Land Cost*	\$4 per Ft^2
6.	Total Land Cost	\$240,000
7.	Cost Per Unit (144 Units)	\$ 1,670
8.	Cost Per Ft^2 Apartment Building (97,000 Ft^2)	\$ 2.50

* Estimate is for low-rent district zoned for high-rise in U. S. metropolitan areas.

SCHEDULE PDB-K

FINANCING COST ASSOCIATED WITH TYPICAL APARTMENT BUILDING

TYPICAL 9-STORY APARTMENT BUILDING - 144 UNITS & 97,000 FT^2 GROSS BUILDING AREA

INTERIM FINANCING (Construction Loan)	
Assumes:	
a. 100% financing ($2.3 million)	
b. Average amount of loan over the year is 50% of the $2.3 million required	
Interest and Points (14%)*	
0.14 x $1,150,000 =	$160,000
PERMANENT FINANCING FEE	
Permanent financing fee of 3.5% of total loan amount (FHA Insured Financing)	
0.035 x $2,300,000 =	80,000
TOTAL FINANCING COST	$240,000

Cost Per Unit (144 Units) = $1,670

Cost Per Ft^2 (97,000 Ft^2) = $2.50

*Interest and points for interim financing ranged from 12% on the West Coast (if money is available) to 13-15% in the Midwest and East. Information furnished by Lomas & Nettleton, mortgage bankers, San Francisco, Oct. 31, 1969.

SCHEDULE PDB-L

U.S. LABOR COSTS FOR EQUIVALENT USSR LABOR INPUT

This schedule is prepared to establish average U.S. man-hour and man-day costs for three categories of labor input which would be expended in fabricating panels for and constructing in the U.S. a typical USSR 9-story apartment building with 144 units and 5,080 square meters of net living space equivalent to 97,000 ft^2 of gross building area. The three categories of labor input are fabricating plant, transport, and site construction labor.

1. Panel Fabricating Plant Labor

   The labor input at the fabricating plant to manufacture panels is equivalent to 1.5 man-days per square meter of net living space for the typical apartment building (Schedule PDB-3). This total includes all production and administration employees associated with the factory. For the U.S., an average hourly labor rate of $4.95 is based on the average gross pay in manufacturing for all full time employees (including management) for 1968 of $7,347 or $3.53 per hour, as reported in Facts For Bargaining, Bureau of National Affairs, August 21, 1969. This rate was increased by 4% to $3.67 per hour to update it to 1969. To this was added fringe benefits at 25.5% (Employee Benefits - 1967, U.S. Chamber of Commerce 1968), payroll taxes at 4.5% and insurance at 4.25%. Total additives were rounded to 35%, to yield a factory employee average total cost of $4.95 per hour.

2. Transport Labor

   The transportation labor cost estimate is based on 0.20 man-day per square meter of net living space (Schedule PDB-3) for the typical apartment building. The hourly wage is the U.S. Department of Labor 30-city average reported in Building Construction Cost Data - 1969, published by R. S. Means Company, Inc. The rate reported includes fringe benefits; to this was added 4.5% for payroll taxes and 6% for insurance to arrive at a total rate of $5.00 per man-hour.

3. Site Construction Labor

   Schedules PDB-3, -4, and -5 have statistics for five large apartment buildings constructed in nonseismic zones in 1968-69 in the USSR. The reported consumption of on-site labor ranges from 1.825 to 2.36 man-days per square meter of net living space, with an average of 2.11 man-days per square meter of net living space. The 9-story apartment building referenced in Schedule PDB-3 is the only one for which data were available on the breakdown of the total construction labor input into the various classifications such as erection labor, plumbing labor, electrical labor, etc. It is this breakdown in Schedule PDB-3

SCHEDULE PDB-L (CONT'D)

U.S. LABOR COSTS FOR EQUIVALENT USSR LABOR INPUT

which is used in Table PDB-L which follows to arrive at a weighted average U.S. hourly and daily labor rate applicable to the average total USSR construction labor input of 2.11 man-days per square meter of net living space for five apartment buildings. The hourly wage rates for the individual classifications are the "adjusted" U.S. Department of Labor 30-city averages reported in Building Construction Cost Data - 1969, published by R. S. Means Company, Inc. The rate reported includes fringe benefits; the "adjustments" add 4.5% for payroll taxes and 6% for insurance to arrive at the rates shown for the various labor classifications. The weighted average rate of $6.40 per man-hour for construction labor is used throughout the various analyses leading to the cost of using the USSR's industrialized building process in the U.S. and paying U.S. material and labor costs in the preceding schedules.

TABLE PDB-L

U. S. CONSTRUCTION LABOR COSTS FOR EQUIVALENT USSR LABOR INPUT
TYPICAL USSR 9-STORY APARTMENT BUILDING

Classification of Construction Labor	Man-days/m^2 Net Living Space*	Average Labor Rate** ($/Hr)	Average Labor Rate** ($/Day)	Labor Cost/m^2 Net Living Space
Below Grade	0.13	6.60	52.80	$ 6.90
Erection	0.40	6.60	52.80	21.10
Plumbing and Heating	0.20	7.50	60.00	12.00
Electrical and Communication	0.10	7.00	56.00	5.60
Crane Operation	0.05	6.75	54.00	2.70
Elevator Installation	0.005	6.60	52.80	0.30
Finishing (Painters, Carpenters, Roofers)	0.90	5.95	47.60	42.80
Miscellaneous - helpers	0.004	5.05	40.40	0.20
Clerk of Works - foremen	0.028	6.95	55.60	1.60
Superintendent's Staff - helpers	0.008	5.05	40.40	0.30
Total and Weighted Average	1.825	$6.40	$51.20	$93.50

* Reference Schedule PDB-3 for construction labor input for typical 9-story apartment building

** Includes fringe benefits, payroll taxes and insurance. Reference U.S. Dept. of Labor 30-city average reported in Building Construction Cost Data-1969, published by R. S. Means Company, Inc. and adjusted to include 4.5% payroll taxes and 6% insurance.

SCHEDULE PDB-M

CURRENT U.S. COSTS USING U.S. CONSTRUCTION PRACTICES

TYPICAL LOW COST 9-STORY APARTMENT BUILDING BUILT IN U.S.

This schedule develops the U.S. unit costs for a Class B building (reinforced concrete frame and concrete or masonry floors and roof) built by normal U.S. construction practices, and having the same shape (number of stories and perimeter-to-area ratio) as the USSR typical building for which costs were analyzed in the preceding schedules and summarized in Schedule PDB-A. The unit costs in Schedule PDB-A are those which would be incurred if one were to build a typical USSR apartment building and use the USSR industrialized building systems (slabs and panels prefabricated in a factory) and consume the same amount of labor and material at U.S. costs. Under these conditions the USSR system would cost $16.80 per square foot exclusive of land and financing costs and profit. These items are excluded from the comparison because they are not items of cost in the USSR.

This schedule shows two sets of costs:

a. Class B - Average excludes built-in appliances, with amenities approximately the same as FHA 221(d)(3) quality. This is very superior to the USSR quality and amenities for which the Schedule PDB-A costs are shown. The current average cost for 12 metropolitan areas in the U.S. is $16.50 per square foot, exclusive of land and financing costs and profit. The average for the entire U.S. is only $15.50 per square foot.

b. Class B - Low Cost excludes built-in appliances, very plain, minimum uniform code, one bath per unit. This is the type of construction in the U.S. generally designated for "public housing"; it is superior in quality and amenities to that built in the USSR for all families - the typical apartment building analyzed in Schedule PDB-A. The current average cost for Class B - Low Cost building in 12 metropolitan areas in the U.S. is $14.20 per square foot, exclusive of land and financing costs and profit. The average for the entire U.S. is only $13.20 per square foot.

c. It should be noted that the costs in Items a. and b. (1) represent superior quality and amenities relative to those in the USSR, and (2) are met in spite of a fragmented market with no guarantees as to annual production or sales.

UNIT CONSTRUCTION COST ESTIMATE IN UNITED STATES

CLASS B, AVERAGE - MARSHALL & STEVENS VALUATION METHOD

Type of Construction	Class B, Reinforced concrete frames and concrete or masonry floors and roofs; multiple-story apartment with elevator.
Quality of Construction	Average, excludes built-in appliances, amenities approximately the same as FHA 221(d)(3) quality.
Base Cost	Class B, Average = $15.67/ft^2$ (April, 1969). (Unit cost includes labor, materials, contractor's overhead and profit, architect-engineer fees, permits and miscellaneous costs. Unit cost excludes land and financing costs.)
Contractor's Profit	Assume at 5% of total cost

Adjustments to Average Base Cost

Structure height: Add 1% for each story over 3	1.06
Perimeter/Area multiplier: Area = 11,300 ft^2, Perimeter = 730 LF	.980
For 9' floor-to-floor spacing	.971
Profit removal (5%)	= 1/1.05

Adjusted Ave. Base Cost = $15.67 x 1.06 x .980 x .971 x 1/1.05 = $15.10/ft^2$

Adjust Base Cost to Local Areas

Metropolitan Area	Adjusted Base Cost	Heating Factor	Local Area Multiplier	Current Cost Multiplier (Updated to Oct. '69)	Local Area Unit Cost Per Ft^2
Atlanta, Georgia	$15.10	$ -.34	.94	1.03	$14.30
Boston, Mass.	15.10	+.38	1.08	1.03	17.20
Chicago, Illinois	15.10	+.38	1.10	1.02	17.40
Columbus, Ohio	15.10	+.38	1.06	1.02	16.70
Dallas, Texas	15.10	-.34	.99	1.02	14.90
Denver, Colorado	15.10	+.38	1.02	1.00	15.80
Los Angeles, Calif.	15.10	-.34	1.05	1.00	15.50
N.Y. City - Manhattan	15.10	+.38	1.21	1.03	19.30
N.Y. City - Excl. Manh'n	15.10	+.38	1.11	1.03	17.70
Philadelphia, Pa.	15.10	+.38	1.05	1.03	16.70
San Francisco, Calif.	15.10	-.34	1.10	1.00	16.20
Seattle, Washington	15.10	.00	1.11	1.00	16.80
Average Current Cost For 12 Metropolitan Areas					$16.50

SCHEDULE PDB-M (CONT'D)

UNIT CONSTRUCTION COST ESTIMATE IN UNITED STATES

CLASS B, LOW COST - MARSHALL & STEVENS VALUATION METHOD

Type of Construction	Class B, Reinforced concrete frames and concrete or masonry floors and roofs; multiple-story apartment with elevator.
Quality of Construction	Low Cost, very plain, minimum uniform code, one bath per unit.
Base Cost	Class B, Low Cost = $\$13.48/ft^2$ (April 1969). (Unit cost includes labor, materials, contractor's overhead and profit, architect-engineer fees, permits, and miscellaneous costs. Unit cost excludes land and financing costs.)
Contractor's Profit	Assume at 5% of total cost

Adjustments to Average Base Cost

Structure height: Add 1% for each story over 3	1.06
Perimeter/Area Multiplier: Area = 11,300 ft^2	.980
Perimeter = 730 LF	
For 9' floor-to-floor spacing	.971
Profit removal (assumed 5%)	= 1/1.05

Adjusted Ave. Base Cost = $13.48 x 1.06 x .980 x .971 x 1/1.05 = $\$12.90/ft^2$

Adjust Base Cost to Local Areas

Metropolitan Area	Adjusted Base Cost	Heating Factor	Local Area Multiplier	Current Cost Multiplier (Updated to Oct. '69)	Local Area Unit Cost Per Ft^2
Atlanta, Georgia	$12.90	$ -.34	.94	1.03	$12.20
Boston Mass.	12.90	+.38	1.08	1.03	14.80
Chicago, Illinois	12.90	+.38	1.10	1.02	14.90
Columbus, Ohio	12.90	+.38	1.06	1.02	14.40
Dallas, Texas	12.90	-.34	.99	1.02	12.70
Denver, Colorado	12.90	+.38	1.02	1.00	13.50
Los Angeles, Calif.	12.90	-.34	1.05	1.00	13.20
N.Y. City - Manhattan	12.90	+.38	1.21	1.03	16.60
N.Y. City - Excl. Manh'n	12.90	+.38	1.11	1.03	15.20
Philadelphia, Pa.	12.90	+.38	1.05	1.03	14.40
San Francisco, Calif.	12.90	-.34	1.10	1.00	13.80
Seattle, Washington	12.90	.00	1.11	1.00	14.30
Average Current Cost for 12 Metropolitan Areas					$14.20

APPENDIX PDB-1

TRANSLATION OF PART OF A USSR BOOK ENTITLED "TECHNICAL PROGRESS IN THE INDUSTRY OF CONSTRUCTION MATERIALS OF MOSCOW," DATED MOSCOW, 1967*
(Published by Stroezdat, Moscow, k-31,USSR)

CHAPTER 2

INDUSTRIALIZATION OF COMPLETELY FABRICATED AND PRECAST CONCRETE HOUSING CONSTRUCTION

At the present time, the industry of completely precast reinforced concrete housing construction in Moscow is carried out at 27 different firms with a yearly volume of production of reinforced concrete and reinforced concrete elements of around 4 million cubic meters (5,100,000 cu. yds.). In addition, some precast concrete is being fabricated by a series of firms of other branches of the industry of the central government. The main products which are fabricated in the firms of this industry are listed in Table 12.

Table 12

Combine No. 1	Fabricates light-weight exterior wall panels, wall blocks for basements, regular brick and light-weight aggregate;
Combine No. 2	Fabricates light-weight concrete exterior panels, precast concrete partition panels, wall panels and electric panels of the attic, balcony slabs, stair flights and landing, elevator slabs, etc.;
Factory No. 3	Makes hollow-core precast concrete slabs and hollow blocks;
Plant No. 4	Makes hollow-core precast concrete slabs, ribbed roof slabs and precast concrete partition panels;
Plant No. 5	Makes hollow-core precast concrete slabs, slab supports and lintels;
Plant No. 6	Makes solid slab panels, partition panels, elevator shaft panels, stiffening walls, and precast concrete hollow-core slabs;
Plant No. 7	Makes sanitary boxes, ventilation shaft elements, partition panels, heating panels, plenum boxes and girders, beam panels for garbage collectors, elements for dry and wet collectors, elements for pedestrian overcrossing and street panels;
Plant No. 8	Makes hollow-core precast slabs, ribbed slab panels, and supports, floor panels for framed construction, detail elements for buildings of the Series II-49, sun-shade slabs, wall panels for entrances, and supports for exterior lighting fixtures;

* Note to Editor: This is one of the books given the U. S. team. It is standard textbook size, with paper jacket showing an office building and blue sky in background. A1-1

Table 12 (continued)

Combine No. 9	Makes interior bearing wall panels, slab panels, wall panels for lean-to ventilation blocks, roof slabs, slabs for machine rooms, wall blocks for basement, and heating lay-out;
Plant No. 10	Makes exterior light-weight panel for kindergarten buildings, schools, and hospitals;
Plant No. 11	Makes precast hollow-core slabs, foundation blocks, school blocks, girders for frame construction, columns with spherical heads for multi-story buildings, and wall blocks for basements.
Plant No. 12	Makes foundation blocks, road panels, and foundation blocks for basements;
Plant No. 13	Makes columns for housing and public construction, girders for block buildings and multi-story buildings, equipment supports, rafter beams, bracing walls, tie beams, slabs for shafts of wells, precast piles, foundation blocks and mats;
Plant No. 14	Makes stair treads, mosaic work, window sills, parapet blocks for school buildings, parapet stones, flower boxes, floor tile;
Plant No. 15	Makes conduits of large and small diamter, sub-slabs, slabs for covering basements, ventilation shafts, slabs with holes in them, stair supports or consoles, foundation blocks and wall blocks for basement;
Plant No. 16	Makes ribbed slabs and hollow-core slabs, girders for apartment houses, beams and slabs for major repair of buildings, lintels, wall blocks for basements;
Plant No. 17	Makes tile, channels, lintels, foundation pads, foundation blocks, border stone, wall blocks for basements.
Plant No. 18	Makes floor and roof slabs, ribbed and hollow-core, trusses, roof girders and beams, details for refrigerators of the Series II-70, details for new aeration station, columns and girders for frame construction, plain support beams, double-T panels, interior bearing walls for the basement portion of buildings, stiffening diaphragms or shear-walls, and road panels;
Plant No. 19	Makes lintels, balcony slabs, eye-brow slabs, corner details, panels for television towers and wall blocks for basements;

Table 12 (continued)

Plant No. 20	Makes exterior walls of light-weight concrete and electrical panels;
Plant No. 21	Makes exterior walls and concrete light-weight block;
Plant No. 22	Makes columns, beams, and girders and posts, tile, road panels, wall blocks for basements and details for a new aeration station;
Plant No. 23	Makes large and small diameter unsupported conduit (large pipes), collector details of rectangular design, elevator shaft, ribbed slab, details of heating systems and round columns;
Plant No. 24	Makes ribbed slabs, columns, foundation beams, slabs for industrial buildings, foundation blocks, hollow-core slabs, tile, collector blocks, road panels, wall blocks for basements, and normal-weight brick.

The Moscow Plant of Reinforced Concrete Pipes or Conduits makes long span and short span pipe, tile, beams, columns, telephone wells, collector blocks, slabs for the covering of underground rooms, roofs for the telephone wells, blocks for the heating system, road panels, fence detail, and hollow-core slabs.

Plant for Wall Material makes blocks for interior walls of apartment buildings and regular brick.

Combine of Construction Material produces the interior wall blocks of so-called silicate-concrete and other machine building components.

The specialization and cooperation of the above plants now carry out the construction of completely precast apartment buildings of many stories and heights as well as industrial and cultural buildings and government buildings for Moscow.

Until now, precast concrete elements, fabricated at Moscow's plants were produced mainly in one of three ways:

a. flowing assembly

b. static assembly

c. conveying

A1-3

It is the flowing assembly which has received the widest acceptance of fabrication. In this method, the elements are subjected to a step-by-step procedure of technology which requires the least amount of labor; the overall dimensions of the elements are limited only by the lifting capacity both in-plant and for transport. Elements of 18 meters in length and 20 tons in weight including the form are being cast at the central location, and are transported into the curing chambers. Columns are cast in horizontal position whereas the remaining items are cast in the same relative position as they will be in the field.

Trussed construction and other elements of longer than 18 to 20 meters, and heavier than 10 to 12 tons not including the form are built by "flexible" technique, that is non-transportable forms and stressing abutments in separate chambers. The conveyer assembly method now has very good technical and economic indices. It allows the fabrication of different types of components without any great waste of time and efforts; however, with this scheme a series of processes are done by hand and there is an absence of mandatory cycle time making it more difficult for a complete automation of the production process. The quality of the product suffers as well.

With the conveying system of production, the components move in the process from station to station according to the principle of pulsating flow with a certain established rhythm.

But existing conveyers which produce precast components do not seem to be in great demand. Their main short-comings are the differential level of moisture, for purposes of curing a stack of panels in a chamber, produces panels of different quality; the numerous stop and start of the product on the conveyer belt, as it goes through the different steps while still in the process of hardening, subjects it to undesirable impact and inertia loads which deteriorate the quality of the product. The formwagons necessary to produce a form rigid enough that it will not adversely affect the geometry of the product become exceedingly heavy and hard to handle.

The conveyer, however, has certain undisputed advantages which are quite beneficial in the production of formed elements which consist of many layers of different materials.

New Two-Level Conveyer Mill

Utilizing the advantages of the conveying techniques and overcoming its most serious disadvantages, the workers of project organizations and plants of the Glavmostroymateryal have successfully put into use a new highly efficient method of producing elements of large dimensions out of reinforced concrete on a two-level conveyer line.

In the new conveyer line plants the length of the line and the number of positions is reduced substantially; also, new formwagons of better designs have been introduced as well as better edge control and more effective ways of thermal curing. This kind of plant allows production of bearing as well as non-bearing elements of large dimensions and of good quality, as well as of good exterior appearance and complete plant fabrication. The distinction from other systems is the fact that in these plants prestressed, precast components can be produced very effectively and economically. These new flow assembly lines give the possibility of incorporation of even greater special detail through cooperation among different firms for completely precast buildings of intricate nature.

In the combines around Moscow, these double level conveyer lines are very specialized; that is, they produce only panels of certain definite characteristics for purposes of specialization in the production of components for multi-story buildings. For instance, at Plant No. 4 this kind of set-up produces only interior partitions for nine-story buildings of Series II-49, and in another it is proposed to produce slabs only.

Two new two-level lines in Plant No. 6 specialize in the production of floor panels of custom buildings; for instance, the 16-story frame buildings of Series MG-601-D and other buildings built under this type designation.

Flat slab panels of the size of an entire room which are produced on these conveyer lines have a very strict geometrical tolerance. Thanks to the use of new highly-rigid forms, the ceiling surfaces have very good appearance and are ready for painting without any further work on the surface. The floor surface is ready for direct application of linoleum on top of some kind of insulation. This kind of panel slab, if necessary, can also be fabricated with prestressed reinforcement.

What do these two-level conveyer lines consist of? First, let's look at one of the modifications to such a line which was devised by the Institute of Moscow Construction. These kinds of lines are now in operation in Plant No. 6 and Plant No. 9.

The two-level line consists of a vertically locked-in (i.e., traveling horizontally) conveyer of the cart type (See Figure PDB-1). The elevator lifts the formwagon from the lower level to the upper level. The pusher moves it to the first position where a bridge crane pulls the components out of the form (stripping the product). The formwagon is then pushed to the position for cleaning and oiling. As the following positions are passed, the reinforcing is put in place and the cast-in components are installed, the electrical conduits are installed as well as the inside piping which are afterwards cast into the panels. The completed form is then pushed into position for concreting. The concrete is poured and compacted with the aid of vibration and finished with mechanical screeds and rollers.

The completed form is placed to the next position where the block-outs are removed, and then to a compartmented chamber for curing by high-pressure steam. After the high temperature curing the component is directed to the area of cooling. Then the cycle is repeated. The formwagons are put into motion by pushers located at the elevator end of the line. The yearly production is 400,000 square meters of panels (i.e. 4,400,000 sq. ft./yr.).

Interior bearing walls are fabricated in 29 different dimensions with concrete of Grade 200. They have a thickness of 140 millimeters (5.5") and a length from 1,720 to 6,060 millimeters (5.7' - 20') and a height of 2,520 millimeters (8.3'). There are also fifteen different geometry panels which are also made from 200 Grade concrete of thickness 140 millimeters (5.5"), length 1,700 to 6,060 millimeters (5.6' - 20'), width 2,560 to 3,280 millimeters (8.5' to 10.8') with cast-in electric conduits.

A two-level conveyer line of a different size is also installed in Combine No. 4. It consists of a chain type vertically locked (i.e. traveling horizontally) conveyer with a continuous (uninterrupted) motion of approximately the speed of a walking man with a driving and take-up pulley; it also has the vertical finishing conveyer.
The maximum dimensions of the components that can be produced in this conveyer are 2.54 m. wide, 4.95 m. long, and 140 mm. high (8.3' x 16.2' x 4.6").

The construction of the formwagon takes place in one central location, and is of a very high quality resulting in similarly high quality and uniform concrete components with minimum variances in geometry, absolutely smooth surfaces and absolutely dimensionally correct appendages.

The new two-level lines have a whole series of construction and other advantages with respect to all of the previously existing lines of production of reinforced concrete components. In particular, when compared to the old line designated BS-6, the cost of preparing a square meter of floor slabs of the old BP-6 costs 3.19 rubles per square meter, and on the vertical two-level conveyer line approximately three to four percent less, that is, 3.08 rubles per square meter. Thus, under the present rate of production a possible saving of 20 kopecks per each meter of panel could be achieved. In addition, one must keep in mind that the components produced by the old BPC-6 necessitated additional re-work or finishing and dimensional adjustments at the rate of 5 kopecks per square meter.

The economic indices pertaining to the vertically-locked two-level line are also quite favorable when compared with the old set-up referred to as NIAT which is being used in Plant No. 1 for the production of slab panels.

Comparing the NIAT to the CKTB type of plant, the CKTB allows a 12.5% greater production per man; also the CKTB system reduces the price by 17% per square meter of a panel and results in a 40% reduction of cost per square meter of slab.

In fact, thanks to the acceptance of the lines discussed herein, specific economic effects on the expenditures mentioned herein per square meter of panel is forecast to be 0.72 ruble. One line using this system gives a yearly saving of around 450,000 rubles.

Improvements in Fabrication of Exterior Panels

In the same way a new technique was devised for the production of the exterior peripheral panels for buildings of the Series II-49 on these new two-level conveyer lines which were installed at Combine No. 1. These lines produce light-weight wall panels in double of single module dimension for exterior panels to be used in housing construction of Series II-49. The maximum dimensions of the panel will be 6,740 by 2,680 by 340 millimeters (22.2' X 8.9' X 13.3").

Two double level conveyer lines and flow assembly lines which are now in production at this combine could provide all the necessary panel work for an overall area of 500,000 square meters (5,500,000 sq. ft.) per year.

The conveyer lines are located in the side spans of the factory building. In the central portion, the cleaning of the ceramic facing is being done as well as the finishing of non-horizontal surfaces. For transportation operations, a 10-ton bridge crane is employed.

The conveyer line consists of two levels; on the upper level are distributed stations and mechanisms for the production and finishing of the exterior wall panels; on the lower level is a compartmented chamber for curing, equipped with electrical curing and heating systems.

The panels are produced in formwagons; the motion is a pulsating type with 24 minute cycles. For the moving of the formwagons horizontally, there are little car pushers; and for vertical transfer, there are elevators located at each end of the conveyer.

The light-weight concrete and the mixes for the lower and upper layer are supplied through a scaffold with two coupled concrete containers. From the concrete containers the mixtures and the light-weight mix are admitted into mix distributing machines and light-weight distributing machines with vibrators.

The technological process for the fabrication of components is described below.

The formwagons are taken out of the slot of curing chambers with the help of the elevators to the stripping station. The panel is stripped with the help of a crane and put onto a transition cart which takes it into the central bay for the cleaning of the ceramic facing and then to a stand for miscellaneous work. From the stand the product goes to a shelf for testing purposes and then into the storage area.

After stripping, the formwagon moves to the station for cleaning and oiling, then for the placing and consolidation of light-weight concrete, two layers of other mix, and screeding. The last process operation on the upper level is the smoothing of the cast product which is done by a special machine for this purpose.

Following this operation the elevator takes the product down to the compartmented curing chamber. The thermal curing is done at 110° centigrade for $8\frac{1}{2}$ hours. The moisture content of the panel, as it comes out of the curing chamber, is approximately 8-12%.

A central control regulates the function of all the separate mechanisms as well as the rate of production.

In addition to the double module and single module panel for apartment buildings of Series II-49, Combine No 1 also produces light-weight curtain wall panels for 16-story frame buildings of Series MG-601D. These curtain type panels are also produced at Plant No. 10 buildings for other types of buildings.

The combine has an automatic light-weight concrete batch plant. The light-weight concrete (Grades 50 and 60) is produced for a unit weight of 950 to 1050 kilograms per cubic meter (60 pcf to 66 pcf) from which are made 32 centimeters to 34 centimeters (12 to 13 inches) thick partition walls. To produce this light-weight concrete a light-weight aggregate produced on the site of the combine out of low-swelling clay is employed. All of the components fabricated at the combine have a durable and sturdy exterior facing material; panels for apartment buildings of Series II-49 have a ceramic tile facing, each tile being 48 by 48 millimeters wide, red or yellow in color; panels for buildings of Series MG-601D have the same ceramic tile, also glass mosaic, etc.

Combine No. 2 for project CKTB has in operation a conveyer automated line for the purpose of producing light-weight double module exterior panels for nine-story buildings for the new Series I-515-9. Different from all the others, this procedure employs a quick stripping after casting and curing through the use of infrared rays.

The compartmented chamber consists of a reinforced concrete tunnel built above the ground. Inside, above and along the sides of the chamber are mounted 954 electric heaters of the tube-type emitting infra-red rays. These tubes contain a non-chromated spiral. The space between the tube wall and the spiral is filled with compacted magnesium oxide.

The line works as follows: the intermediate carts supply the conveyer with clean and oiled formwagons. In the formwagons are placed carpets of ceramic facings on top of which is placed a 20 millimeter (0.8 in.) thickness of concrete mix before placing the reinforcing steel.

The formwagon together with the ceramic facing and the reinforcing steel is then put on a vibrating table. Here, the concrete is placed and compacted. The placing machine finishes the top surface. Then the edge forms are dropped off and the remainder is moved into the curing chamber. The component is then heated for $1\frac{1}{2}$ hours at a temperature of 60° centigrade and is then put in position for the finishing. Then it is put into another curing chamber for 5 hours at temperatures ranging from $90\text{-}95^{\circ}$ centigrade.

The product and the form are then moved onto scales. At the next station, the product is stripped and the formwagon is sent on for re-cycling. The stripped product is handled by a bridge crane and brought to position for finishing the window and door frames. It is then taken to the storage area.

New Line "NIAT" - Principal Moscow Industry of Building Materials

NIAT, a collective of constructors and fabricators in cooperation with each other, has established at the reinforced concrete Plant No. 18 a universal automated combine for the fabrication of reinforced concrete or light-weight concrete panels and construction of a very high accuracy with very well finished surfaces.

There isn't anything like it in the entire world. It is an assembly of automatic, uninterrupted functions for the preparation of the very large panels with the use of hydraulic pulsing drive and electrical curing.

The geometry of the panels has very strict dimensional accuracy. The high quality of the products which is greater than than of any other similar technologies, results in a bypass of all the usual necessary last touches for the purposes of making things fit together. A central console controls the rate of production of assembly.

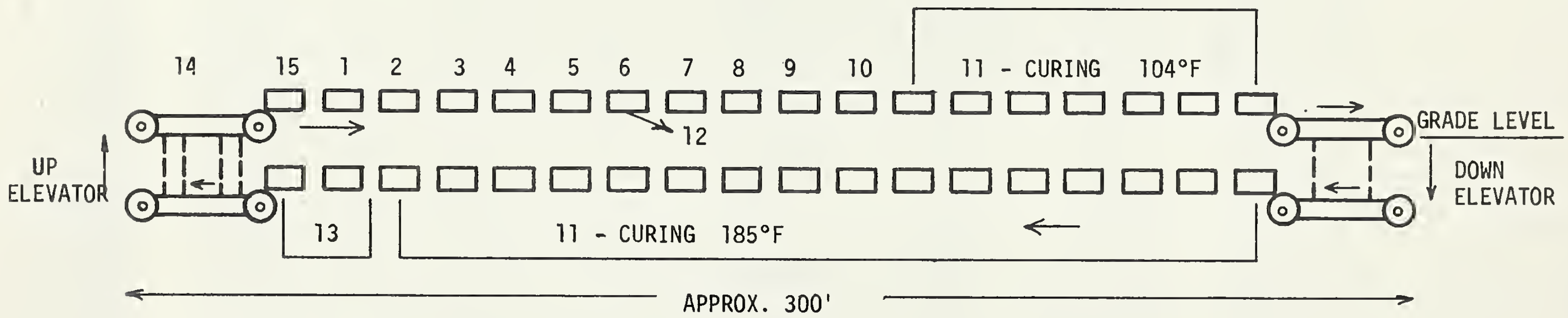
This combine is very compact and produces 1 million square meters of product (11,000,000 sq. ft.) per year which means that a threefold or fourfold increase in production of this kind of work is achieved. Along with this there will be a reduction in the working force. At this plant, some of the more sophisticated prestressed concrete elements can be fabricated.

This technique is so diversified that it is possible to fabricate all kinds of elements for apartment buildings of 12, 17 and 25 stories in height, as well as for schools, hotels and other buildings. Indeed it is this kind of approach, i.e. the production of only a certain limited number of standard panels on each production line, which should be applied to construction of all types in order to answer today's needs for precast concrete construction.

The acceptance of the combines in the building industry as well as of the two-level conveyer line type of equipment represents significant progress toward mechanized construction for mass production of multi-story apartment buildings. This acceptance forms the basis for the change of the building industries from conventional construction into highly mechanized and sophisticated productive sciences as defined by the Thirteenth Convention of the KPSS.

FIGURE PDB-1

SCHEMATIC OF TYPICAL USSR CONVEYERIZED CONCRETE PANEL FABRICATING LINE



1. CLEAN AND OIL FORM
2. PLACE PREFABRICATED REBAR "CAGES"
3. PLACE CONDUITS, PIPE, WIRE
4. PLACE BLOCKOUTS (FOR WINDOWS, DOORS, RECEPTACLES)
5. POUR CONCRETE FROM OVERHEAD HOPPER OR BELT, AND VIBRATE
6. SCREED
7. TRIM WASTE
8.
9. } PREHEAT CHAMBER
10. REMOVE BLOCKOUTS
11. CURING - 104 - 185°F
12. WASTE RECLAIM CONVEYER
13. COOLING CHAMBER
14. TILTING BED FOR REDUCING PANEL STRAIN DURING LIFTING FROM FORM
15. LIFT PANEL FROM FORM BY OVERHEAD CRANE

NOTE: TOTAL CYCLE VARIES FROM 2 1/2 TO 12 HOURS DEPENDING ON CURING TIME

APPENDIX PDB-2

EXCERPTS FROM "RAPID CONSTRUCTION OF APARTMENT HOUSES IN THE UKRAINIAN SSR BY GOSSTROY UKRAINIAN SSR, SCIENTIFIC-RESEARCH INSTITUTE OF THE CONSTRUCTION INDUSTRY, KIEV, 1969.

The building was divided, within each floor, into four crane-grab sections for the purpose of rapid erection. The erection was done in two parallel production lines by two half-crews, each of which worked on two crane-grab sections (half of the building) and used one tower crane. To eliminate the transportation of identical parts and structures for each production line during the same day, one half-crew always started working on a floor a day later than the other one.

Erection of each floor took two days, i.e. one day, three shifts each, per one crane-grab section. Other structures of the building were erected in 18 working days, and roof and its covering was completed in four days. Total erection time of the above-ground part was 22 days as compared with an estimated time of 23 days.

The following technique of work progress at each crane-grab section was adopted: first and second shifts of each erection day installed the panels of outer and inner walls at two adjacent crane-grab sections, welded anchoring parts in place and filled the joints of inner walls. Simultaneous erection of wall panels at two crane-grab sections was adopted to increase the work frontage and avoid the possibility of erectors standing idle in case of untimely delivery of certain panels. During the third shift of the first erection day and during three shifts of the second day the following operations were performed: installation of partition panels and concrete floors in bathrooms, laying the base for floors, erection of floor panels, stairways, balconies and trash-ducts, welding of anchoring parts, sealing of wall and floor joints and caulking of partitions.

While an upper floor was being erected, the following work was being done at a floor below (one floor between): plumbing and electrical wiring, carpenter's work, plastering, installation of door frames and finishing of woodwork.

Plumbing and electrical wiring work was done during the first shift starting on the fourth working day, carpenter's work starting on the sixth day, plastering and laying of floors in bathrooms on the eighth day.

Finishing work was done after the erection was completed and after the roof was finished.

For finishing work, the building was divided into sections in the same manner as for erection. The work was done simultaneously in all four sections of a floor and progressed from the ninth floor down. Finishing work was completed in 21 days, working one shift a day. The total construction time of the above-ground part of the building was 45 working days or 60 calendar days.

The site for the building constructed by this rapid method was provided with approach roads, parking lots for semitrailers (panel-carriers), areas for storing of structures and materials, crane tracks, two tower cranes (erected and tested), temporary facilities for everyday convenience of workers, offices of foremen and work superintendents, and fences around danger zones and the construction site.

Temporary roads, 3.5 m. wide, were made of prefabricated reinforced concrete slabs, designed to carry heavy panel-carriers with a total weight of up to 25 tons. Parking lots for transportation vehicles were located in the vicinity of every crane and provided enough space for simultaneous parking of four semitrailers or trucks.

The building was erected with the aid of two S-419 tower cranes of 20 m.boom-out and 3-5 ton lifting capacity. Each crane serviced two crane-grab sections or half of the building. To ensure safe, simultaneous operation of both cranes, their action zones were separated by movable rail stops, set at a distance of 31.4 m.from each other which made it impossible for the booms of two cranes to come closer than 6 m.to one another. The following order of crane work was observed during erection of the structures: crane No. 1 works at the first section (crane-grab), at the same time crane No. 2 works at the third section (crane-grab); crane No. 1 works at the second section (crane-grab) while crane No. 2 works at the fourth section.

Erection of outer and inner walls was done by lifting the panels directly from the panel-carriers.

Two truck tractors Mark MAZ-504 were used to transport structural items to the construction site. Each tractor pulled three semitrailers Mark NAMI-790 and one semitrailer Mark MAZ-5242. By having each tractor pull three semitrailers, it was possible to use a shuttle method in the transportation of structural items.

The number and capacity of the storage areas was calculated to hold a reserve of structures and materials for two floors of the building. An area was also provided for assembling the items of elevator shafts into large sub-assemblies. Two areas were provided with racks for storage of reserve outer and inner wall panels. In order that such number of storage areas could be placed in the zone of each tower crane, the crane tracks had to be extended 21 m beyond each end of the building.

For sanitary and everyday needs the following temporary structures were built: two accommodation barracks for erectors, two for plumbers, one for electricians, seven for finishing workers, three for offices of foremen and work superintendents, a shower-bath and a toilet.

Electricity, water, steam and gas were provided from permanent city lines. Mortar and concrete were supplied by a central mortar-concrete yard.

To prevent loss of time due to power failure in city power lines, the construction site was provided with a mobile electric power station. In addition to ready-mixed mortar brought to the site, some mortar was prepared at the site in a small mortar mixer. Crane parts which most frequently break down were also kept in stock.

Very thorough preparations, which would ensure a successful achievement of rapid construction, were made before erection of the building was started. A plan of work progress for the rapid construction of the building was worked out. An order was issued to the House-Building Trust in which tasks of all the sections participating in the project were defined.

At the job site, all the work on the underground part of the building and engineering structures on the site was completed by the general contractor and accepted. Center lines of the building were plotted by surveyors and screeds for wall panels were provided.

The job site was prepared in accordance with the master plan, cranes were erected and tested and all necessary equipment and tools were brought to the site. Cross-ribbed floor panels, partition panels and floor material, stair stringers and platforms, anchoring parts, reinforcing rods, etc., were stocked in the amount required for two floors of the building. The job site was decorated with posters, slogans and other means of visual propoganda.

Particular attention was given to the organization of efficient and timely supply of products and materials to the site and their delivery in full conformity with transportation-erection charts and supply records. Control over the delivery of products and materials was given to the chief dispatcher of the Trust.

To ensure reliable communications with the control room of the residential area of the Bereznyaki complex, two radio stations of the ARS and "Altoy" type were installed. The dispatcher of the complex had a two-way radio communication with the central control room of the Trust. This made it possible to record all troubles and to take proper measures for their prevention and elimination, and also to control the departure and arrival of all transportation means.

The crews were made up and they were given instructions regarding the work techniques required in the rapid construction. Work-progress schedules, showing the amount of work required for each operation and their completion dates, were brought to every crew regularly.

CAUDILL

REPORT

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How it really is and what we saw may be two different things all together. It is our guess, however, that we saw the best. If so, the best is none too good as far as quality is concerned, particularly with regard to housing. But quantity is something else.

QUANTITY CONSCIOUSNESS

The Soviets are numerical. They love to quote statistics. They respond to the assigned quotas. They are solving the problems of numbers. And they are doing an amazing job turning out thousands of buildings using industrialized methods both in the factory and on the site. Their factories hum away 24 hours a day turning out building components like cookies, which is not a bad way to describe the very large concrete components. These precast and sometimes prestressed components are, so to speak, cooked in hollow forms containing hot water, or in huge electric ovens so that these large pieces of concrete buildings will be strong enough to handle within 2 1/2 to 3 1/2 hours. The Soviets can turn out some very large panels every 15 to 30 minutes. They loved to throw these numbers at us. And they should be proud. They are solving their housing shortage problem their way and are doing an excellent job quantitatively.

Everyone we met had met his quota, or more commonly, had exceeded it and was enjoying the premiums which go with going faster than the plan calls for. At least that's what we were told. If the quota had to do with building so many dwelling units, they did it. Or so many windows, they did it. Or so many 3-D sanitary boxes*, they did it. Or even so many diamonds manufactured from raw material shipped from Siberia, they did it. Even a completely new city for 200,000 on the outskirts of Leningrad -- in four or five years, they will do it. At least that was the impression we received.

The Soviets are most numerical and quota conscious. Numbers have great meaning to them. And rightly so. They have a terrible task of getting a roof over every family. As it is now, young married couples have to wait 1 1/2 to 3 years before they can move out of the one room which they probably occupy in the too small apartment belonging to one of their parents. Numbers are important. And as far as we could tell, the Soviets are doing a good job of providing the numbers.

* Precast bathrooms

• Becoming More Quality Minded

By 1980 they should be caught up with the basic housing requirement. By then, however, the people are not going to be satisfied with just "getting a roof over their heads." They will start asking, "Why do the living units have to be so small and why do the 'houses' have to be so ugly?" They are already beginning to complain about sleeping in the tiny living rooms and about trying to cook decent meals in the unreasonably ill-equipped, small kitchens, if they are lucky enough to have kitchens -- some don't. There are reasons to complain.

Both officials and users of the housing projects are fussing about the extremely poor workmanship which makes new buildings look old and patched up before anyone has moved in. One of the US delegates described one set of houses as "instant slums." In our eyes and with our yardstick, he is close to the truth.

What appeared to us as an instant slum may be a palace to the peasant of the Republic of Uzbekistan, who had been living in a run-down adobe house all his life. Not all of the Soviets are peasants, however. Some are high governmental officials, educated to the hilt, who want more than mere shelter. Some are college professors who have been around and have seen where other college professors of the world live. Some are professional people who read the journals and realize that other professionals throughout the western world are faring much better, particularly where housing is concerned. These highly educated, informed people are not too happy, even now, living across the hall from truck drivers or construction workers who have exactly the same kind of apartments and who pay the same rent as they do. Since all buildings are heavily government subsidized, the rent is so low that it takes care of only half of the operation and maintenance cost of keeping the houses running. Low rent is great, but since one cannot buy his own home, and since buying a car is completely out of reason, the well paid government employee (and who isn't a government employee in the USSR?) is perfectly willing to pay more to get a better dwelling than the truck driver who has not worked nearly as hard as he to get his education, and who is not making nearly the contribution to fulfilling the goals of the USSR. "All Russians are equal" is true, but as the old saying goes, "Some are more equal than others." The highly competent, well-educated Soviets are "more equal" and the government knows it. And it knows that there will be an ever-increasing pressure to produce better and more spacious dwellings for these people.

The Soviet Union is a capitalistic haven with only a 15 percent income tax. The comparatively well paid professional or politician is perfectly willing to pay for better things for his family. He is willing to buy something better, but there is nothing to buy in the way of a better apartment, and most certainly not in the way of a private home. And that is his complaint -- he wants something better. In Moscow, for example, everyone lives in an apartment. A few of the "more equal than others" can build summer cottages on government-leased land, but that is about it. There will be a greater demand for quality. Now quality is simply not there. The high officials with whom we met realize this and it may be that in the future there will be quality goals as well as quantity goals. The aspects of quality concern:

- The quality of construction relating to materials, their connections, and workmanship.
- The quality of design relating to sizes, affinities of spaces, and architectural effects.

• Quality of Construction

Consider the first: Many of the exterior panels were veneered with standard small ceramic tile about 2"x 2"x 1/4". At least there was an attempt, as small as it might be, to transcend mere shelter to architecture. The veneering was done at the factory by simply placing sheets of the tile face down in the bottom of the horizontal molds. Very logical. Very economical. And supposedly a way to give quality appearance to a raw wall. The trouble, however, was that by the time the panels were installed, they had been banged around so many times, either at the factory, enroute, or on the construction site, that most had missing or broken tiles. Patching of course was done at the site, but not very satisfactorily. There always seemed to be a mangy effect caused by missing tiles. We saw a good number of walls of tile veneer which had been painted, thereby negating the original intent of using a material which has its own built-in color and texture, and which supposedly is free of maintenance. We thought a wall with no tile would have been better than a wall with missing tiles.

Other attempts at decorating the exterior panels were just as unsuccessful. Sometimes chunks of glass or colored rocks were placed in the bottom of the horizontal molds to give a "salt and pepper" effect. Generally, the chunks were too thinly scattered to create any decisive texture or pattern. The few examples of washed aggregate panels were not too bad considering the overall surface, except at the butt joints or corner connections which invariably would appear too jagged.

The joining of the concrete panels was particularly poor -- indecisive and irregular. Attempts to straighten out or articulate the panels by painting on black stripes were esthetic disasters.

The most successful attempts to improve the exterior concrete surfaces, some of which could have been left untouched and would have looked just as good, consisted of painting the exterior surfaces white, thus pulling the panels together and camouflaging some of the poor detailing.

The worst detail was the standard window sill. In Moscow and Leningrad the sills were particularly bad. At first we thought the use of thin sheet metal to cover up the wood, brick, or concrete sills was a remedial situation. But no, even the newest buildings had this very bad, expensive and unsightly galvanized sheet metal sill covering.

Window and door painting was unreasonably bad. One of the US team members remarked after seeing the "sags" on the window sash, "It is impossible to put that much paint on." The unevenness also appeared too thin (holidays) on the window and door frames. The only consistency was that all painting was bad, with one exception. The team visited one "show case" window factory which was doing an excellent job of spray painting the wooden windows at the factory. The houses have no steel or aluminum sashes. Wallpaper, the usual interior surface, was also very poorly applied. In some cases there had been no attempts to match the bold flower patterns where patches had been made. The articulated patchwork did nothing to enhance the interior design. Another US delegate made this remark about the poor finish: "Apparently the finishing crew came on at midnight and there were no lights." Indubitably, finish work was appalling.

Inquiries concerning schools which might produce craftsmen capable of properly finishing a building resulted in the stock answer: "We've solved that problem." To the US team, the solution was not even a speck on the horizon.

In fairness to the Soviets, two things should be said: First, most high officials are aware of the problems and intend to improve the situation; Second, there are a few isolated examples, among the buildings referred to by the Soviets as their "unique buildings," which are skillfully detailed and masterfully finished. In this respect, the best building the team saw was the headquarters for the Young Pioneers in Kiev.

• Quality of Design

Now consider the aspect of quality of design as related to sizes, affinities of spaces and architectural effects. At this time the Soviet officials seem to be a bit more concerned with the quality of spaces than with finishes. Apparently there is much pressure now -- they anticipate more -- to make the rooms larger and the apartments more livable. The usual living room is rarely over 10 feet in width. When 4 or 5, and often 6 or 7 people (families have to double up) try to crowd into such small rooms, there is reason to complain. Most complaints, it appears, are centered on the inadequate kitchens. We noted at least one example where the design of a standard 9 story building built by one combine was being changed to cut down the size of the stair wells, giving the space to the kitchens. Fourteen months were required to make this change. The egg-crate characteristics of large panel construction require a technological as well as an economical approach to increasing the size of "living units." To enlarge the "living units" also will require expensive retooling in the factories. So the problem of making the apartments larger will be difficult to solve. There is a technological limit to the egg crate.

In connection with one of the experimental "houses" designed by Architect Osterman in District #10 in Moscow -- often referred to as "the house of the future" or "the house with extensive services" -- attempts were made to do away with the individual kitchen all together. In this high-rise apartment, now under construction, there is a common kitchen and dining room on each floor servicing a dozen or so families. Whether the idea will be well received remains to be seen; however, the cry is for larger kitchens, not their elimination. But we admire the Soviets for experimenting on both sides of the spectrum.

Most "houses" were planned as a part of a neighborhood unit which approached a self contained situation with its own nursery, kindergarten and school. Children did not have to cross busy thoroughfares. The neighborhood unit also contained stores and service shops. In every case landscaping was provided, but the maintenance of the grounds was nearly nil. Weeds and uncut grass prevailed. In fact, it was not until the US team reached Kiev that a lawn mower was spotted.

Most of the "houses" had the same basic floor plan -- four apartments clustered around a stair-elevator core. And most looked alike. This sameness created a dullness which even top officials acknowledged and deplored. Even in the largest new town complexes -- where as many as three combines had erected three different kinds of "houses" with varying heights and types -- there still was this deadening dullness. Regardless of where the team visited, it saw standard houses in standard towns resulting in standardized ugliness. The quantity was most impressive, but the quality was most depressive.

CLIMATE CONTROLS

There seems to be no regard for regionalism in the USSR. One exception was in Tashkent. Here serious attempts were made to regionalize the living units to fit the climate. In the newer apartments, the balconies were made larger and became sleeping quarters. One new apartment block in a new district outside of Tashkent, called Chilanzar, had an inner court arrangement similar to patios. Parenthetically, this neighborhood unit was designed and erected by Muscovites as their gesture toward rebuilding Tashkent after its partial destruction by the 1966 earthquake. Another climate control device in this same housing group which the team did not see elsewhere was the glass folding doors which opened the entire living room to the large sleep-on balcony. To facilitate cross ventilation, many windows were door size. One official in Moscow said, "There is little hope for air-conditioning during the next decade," but a high official in Tashkent said that air-conditioning "will have to come and soon."

In Leningrad, Kiev, and Tashkent, in contrast to Moscow, balcony boxes were used both for flowers and vegetables. In Moscow tenants preferred the upper stories of the high-rise, while in Tashkent, a much warmer climate, the tenants gave preference to the first three stories. The cooling effect of trees obviously had its influence.

INNOVATIONS ENCOURAGED BY EARTHQUAKE

Although the damaging effect of the 1966 earthquake in Tashkent was great -- some 96,000 dwelling units, 225 nurseries and kindergartens, 180 schools, and 118 medical buildings were destroyed -- all of Russia seems to have answered Tashkent's call for help. Cities such as Moscow and Leningrad and Republics such as the Ukraine sent train-loads of materials and professional people to help rebuild the city.

There has been a beneficial loosening up of attitude toward complete standardization because of the earthquake. Design innovations have appeared probably for these two reasons:

- In times of emergencies bureaucratic controls seem to have more slack, providing opportunities for trying out new concepts of design.

- Design and construction teams from outside the Republic of Uzbekistan which contributed to the exceedingly fast rebuilding of Tashkent probably felt less restraint because they were "away from home" and without the fear of political pressures if innovations went wrong.

The aforementioned Chilanzar, a complete hew housing district on the outskirts of Tashkent which had a considerable number of innovations to facilitate natural ventilation, was designed and built by Muscovites. No. 7 Neighborhood Unit, in the central portion of Tashkent, having two experimental air-conditioned apartment towers and an experimental school was designed and constructed by the Republic of Ukraine. It is doubtful that these design innovations would have been made were it not for the earthquake emergency and the "outsiders" who had the unusual opportunity to design buildings with the challenging problems of speedy construction, the hot, arid climate, and resisting the seismic forces of the Uzbekistan Republic.

ARCHITECTS TAKE THE BACK SEAT

Architects have taken a back seat during the past decade because of industrialization of buildings. Except in rare cases, architects are never employed in the factories or in the combines, which both manufacture the concrete components and erect the buildings. And when this does happen, the architects are relegated to the minor roles of interior and exterior decorator. It was pointed out by Russian officials that there was a shortage of architects which was the reason for their relatively minor contribution. Perhaps this is so. On the other hand, the architects may not have adapted to their new role created by industrialization. One US delegate -- obviously an architect -- said: "You have no problems of design and finish that could not be solved if you had 50,000 more architects." But if architects are content to be interior and exterior decorators, then the breed is on its way out in Russia. But someone must sponsor buildings which possess architecture. The problem of poor design is as basic as this: Soviet architects are starving intellectually and professionally. They haven't been active enough. Standard plans, standard construction methods, and standard materials tend to stifle creativity, but that's not all. Even worse, there is a deterioration in design talents simply because architects are not being used often enough. When machines or muscles are not used, they deteriorate. So it is with architectural talent; talent must be put to work.

Compare the typical US architect with the USSR architect. The American architect will design at least 5 to 10 buildings a year. On the other hand, the Soviet architect is lucky if he works on one building in two years. There is good reason for this. A combine, let's say, which manufactures a 16-story apartment block, cannot afford to retool every time a bureaucratic architect decides he can design a better building. It is true that the factories do try to make continuous improvement, but to hold to the example, it will still be a 16-story building with the same basic floor plan and external expression. It is still the same "model." Most combines change their "models" about every three and a half years. With the expensive, heavy equipment they use they could not do otherwise. This leaves the conceptual designers either on an inactive list or relegated to the irrelevant until it is time to design the new model. If either

Dr. Michael DeBakey or Dr. Denton Cooley were restricted to one heart operation every two or three years, their great surgical skill and talent would deteriorate fast. So it is with architectural design skills and talents. Nourishment through use and experience is absolutely necessary to advance the art. The state of the art in Russia at this time is comparatively low. Standardization made it that way.

CATALOG SYSTEM -- ARCHITECTURAL HOPE

There is hope that in the future the Soviet architects will flex their architectural muscles and give life to the monotonous, deadening dullness of the typical multistory "house." Hope lies in the so-called catalog system. The State Committee on Civil Construction and Architecture of Gosstroy of the USSR has developed a series of catalogs for prefabricated building elements which have mandatory use both for designing and manufacturing. Theoretically the system will provide for interchangeable components and will allow options of choice which will free the Soviet architects from unreasonable restraints. It is a great idea -- providing all the benefits of mass production and the opportunities of options of choice. The architects are living in hopes of a brighter future in which they can return to the busy construction scene to make buildings, particularly housing, which possess the human values related to architecture. There is no doubt that architects can improve the situation if given a chance. The catalog system will restore their authority and offer them the opportunity to advance the art. Even more important, they will have the chance to provide the masses with spatial amenities and pleasant, inspiring places to live -- a step far beyond just "giving them a roof over their heads." The catalog system might be just the thing to turn an architectureless environment into one where people will love to live.

Just when the catalog system will arrive is another question. One official was very pessimistic. He said that "such a system is still just a dream and far from reality." Others were optimistic and felt that if this system didn't work, then other means would be found to relieve the awesome sameness of the typical neighborhood unit. During the final wrap-up session of the US delegation in the main office of Gosstroy, Moscow, an official summarized the situation. "We readily admit that there are too many buildings of the same type and the districts are looking too much alike. The government is taking action to make the factories more flexible. One target is to create new factories, each of which will be able to manufacture more than one type of house. We are also seeking ways for the various factories to build interchangeable components which will encourage cooperation among the various combines and specialized trusts. We see the need and are taking steps to create conditions which will allow architects, engineers, manufacturers and builders to provide dwelling blocks which will vary in character, size, and height."

PROTECTING AN ARCHITECTURAL HERITAGE

It was most interesting to the visiting US team to see the "love and tender care" which the Soviets are giving to old buildings and to the "old city." This was particularly evident in Leningrad and Kiev, both beautiful old cities. One official said, "We would never put one of the dull standard houses in the middle of our beautiful city." Generally the old cities are left pretty much the way they were. Where renovations are necessary, the old buildings are gutted of their internal wood structures and replaced with precast concrete floors to eliminate fire hazards. The external appearances of the buildings are restored to their original facades as well as possible. When new governmental buildings, hotels, office buildings and the like are necessary within the old inner city, such buildings are classified as "unique buildings" and design-wise are tailor-made. These new "unique buildings" are comparable in quality to some good ones in the US, but none could be considered as a pacesetter.

"SPACE STRUCTURES"

Where housing fell down in quality, the large space buildings -- factories, bus barns, sport arenas and other large buildings which the Soviets call "space structures" -- were most impressive in design quality and technology, particularly the latter. In Leningrad one space structure factory manufactured and erected a giant building with a 96 meter span (about 315 feet). The roof structure was made up of precast double curved thin shell sections welded and grouted together during erection to form the great roof of double-curved barrel concrete vaults -- a beautiful structure. This Bus Service Barn epitomizes daring design and engineering competence.

Another outstanding engineering/architectural achievement in the way of space structures was the Bus Garage for 550 buses in Kiev. This unique building, both in the real sense and the Russian sense, was designed and erected by Combine Trust No. 1, which specializes in unique buildings. Heading this prize winning combine is an architect who said that the plans were to build a standard rectangular building, until he intervened. "A building must have a soul," he said.

This one does -- a most imaginative, stimulating structure. It is circular in plan -- 160 meters (about 525 feet) in diameter. The roof is supported by 84 columns which carry a reinforced concrete compression ring that serves to anchor 84 cables strung from a concrete middle core. Precast thin shells rest on the cables. This hung roof structure was designed and pre-tested for wind and snow loads by use of a one-tenth full size model. A most innovative solution was used to construct the compression ring. Large precast "forms" were built at the factory; then erected over the 84 columns to complete the ring. Using this form like a pie crust before the filling is poured in, the reinforcement was installed and the hollow ring-form was poured with the final batch of concrete, tieing the ring together and giving the hung roof cables the necessary anchorage to support the superimposed roof structure.

Most factories were beautifully done, using standard prestressed light roof trusses, columns and girders. Except in rare instances, all were of concrete. The column supports and the overhead crane girders in the factories took on a classic look which gave the impression that the structures possessed as much esthetic authenticity as engineering exactitude. The factories epitomized systems building and were far better than the products they produced.

THE UNIQUE BUILDINGS

The US team saw many recently constructed "unique buildings" which were designed without the imposing constraints of standardization which characterize the housing industry. As already mentioned, the best of the lot was the headquarters for the Young Pioneers in Kiev. Another excellent building, having even more architectural unity but considerably more humility, was a restaurant in a park in Kiev. It was most fitting for the environs -- a wood structure, with a most unusual roof form, which literally grew out of the landscape. Frank Lloyd Wright would have loved it.

The largest unique building appeared to be the gigantic Rossia Hotel in Moscow consisting of over 3,000 rooms. It is the largest hotel in the world, but certainly not the best. From the standpoint of architectural form there is much to be desired. The Russian heavy dullness prevails. From the standpoint of function, it is suspected that the Soviets wish they had taken Conrad Hilton's advice and built three instead of one.

Hotel Sovietskaya in Leningrad, built two years ago, was a different animal -- better in many ways. It was relatively free of the heavy monumentality and some detailing was superb -- the integrated lighting of the guest rooms and the stairway approach to the main dining room, for example. The guest rooms had a generous amount of glass. For the most part, however, the architects got caught in the bottom of the cliche barrel. There was a considerable amount of meaningless form lacking in structural significance. Circulation was not thought out carefully. This resulted in a large outdoor terrace virtually inaccessible, and in forcing the guests who wished to go from one part of the hotel to another to take two different elevator trips. The hotel looked much older than its two years.

SOVIET SCHOOLHOUSES

The delegates went through only two schools, but saw a good number of them from their cars. The schools were easily distinguishable from the houses. Because of larger spans required for educational facilities, the factory-builder combines which build the egg-crate houses cannot build schools. Schools are built by specialized trusts. A few years ago the standard plans called for five stories, but have now been reduced to three stories. Judging from outward appearance, the schools are far below the quality of American schools. The experimental school in Tashkent, donated by the Ukrainians, did approach the outward appearance of American schools built ten to fifteen years ago when stress was on natural lighting. If the word "experimental" related to education, there was no evidence of it in a typical classroom which made room for 38 children regimented in fixed, old-fashioned double desks, complete with the ink wells on each side of the desk -- something out of new England around the turn of the century. The other school which the US group visited was in the collective farm, Kodaky, a village in the Vassildov district of the Kiev region. This secondary school for 560 pupils is situated on the town square and might well have been designed in the US 50 years ago. It too had fixed desks, two at a desk -- again with the ink wells! Fountain pens and ball points are available.

Classrooms were bare with an absolute minimum number of blackboards and no tackboards. Lighting fixtures were of the concentric ring type used in California about 20 years ago, but they were installed close to the ceiling causing undesirable "hot spots." The floors were painted wood. There were many potted plants which improved the otherwise drab interior. Without a doubt, the schoolhouse in Russia is behind the times.

INDIVIDUAL HOUSES

In the same village there were two-story single dwellings and two-story double dwellings -- a rather nice change from the beehives of stacked apartments in the cities. In fact, one of the delegates remarked, "I would like to live here." However, he decided not to stay. Of special interest were the red tile roofs and the painted Ukrainian symbols. The landscaping at this model village was in complete contrast to the poorly maintained gardens of the housing districts in the cities. The tenants seemed to care. The individual houses were far better than the "modernistic" designed public buildings in the village, such as the school already mentioned, the Palace of Culture, the Administration Building, the Trade Center, and a four-story 12-apartment building. It is rather sad to see the Palace of Culture -- conceptually a unique device for "keeping 'em down on the farm after they've seen Kiev" -- clothed in a 1930 Beaux Arts slipcover. Despite the sincere and significant intent, it's not a good building. The architects apparently had been looking at too many foreign magazines where the larger buildings were concerned, but they did their task exceedingly well with the one-family and two-family dwellings.

The villages just outside of Leningrad had a considerable number of single dwellings. The heavy wood construction, contrasted with colorful and light "gingerbread" decorations, was indigenous to the region and had a spirit entirely lacking in the monotonous apartment high-rises of the cities. The single-family house obviously is on its way out in the US as well as in Russia. Nevertheless, if city dwellers are to be satisfied with living in stacked up boxes, these high-rise houses must have a spirit like that which emanates from the early log houses in the Leningrad area. Certainly not the same spirit, but a new kind of spirit which carries an aura that makes a person feel good about his environment. The city dweller has as much right to architecture as those in the rural areas. But this is a universal problem, not just Russia's problem. It is the architects' and engineers' greatest challenge to produce buildings which possess architecture -- which can inspire and stimulate better living, and which can help make a man a better person. It is much easier to do this with single dwellings. The users themselves can make certain adjustments in landscaping, space, form, color, and texture in order to generate architecture, thereby relieving of a certain amount of responsibility the architects, engineers, manufacturers, and builders whose main task is not only to "put roofs over their heads," but to raise shelter to a higher plateau which is architecture. The Soviets cannot continue to build single dwellings, but they can learn lessons concerning human values related to their fine little houses, both old and new.

SUBWAYS AND BUS STOPS

Mass transportation facilities, specifically bus stops, above-ground commuter train stations, and subway stations were comparable to and on the average exceeded those in the US. The bus shelters were architecturally clean with large glass panels serving as windbreaks. The subway stations were exceptionally well lighted, and were made of high-quality, low-maintenance materials. For example, in Leningrad the stations were lined with marble. Very impressive -- clean, simple details. The architectural motifs, however, were most incongruous with the 20th Century. One would expect subway design, of all things, to possess the spirit of today. Although of the same marble, each station was of a different motif, which in itself is a good idea to distinguish one from another and to give the users a sense of place. The way it was done was bad. For example, one station was in bastardized Doric style. Another looked "modernistic" -- something that might have come out of France in the late twenties. A third was carried out in fake arches. These "stage sets" lacked authenticity, architecturally speaking. Nevertheless the Soviets have a right to be proud of their subways -- and they are.

KALININA STREET -- MOSCOW

The US group saw some strong evidence of bold city planning. In Moscow, for example, the new street Kalinina, which thrust its way through the down town, was extremely well done with great, set back, large walks, to preserve precious downtown space. On this street is the headquarters of the Council of Mutual Economic Assistance (SEMA). One of the Russians called it, "The Common Market of Communist Countries." It was a bit jumpy, architecturally speaking, but at least the building broke away from the heavy Russian modern style as exemplified by the huge Hotel Ukraina just down the street.

On this new street there are also four V-shaped office buildings of approximately 25 stories, which house eight ministries of the government. This area is a fine example of good urban design. The thin slab office buildings were designed much better than the high-rise apartment blocks. One of the nicest features of this group of four apparently came about by accident. About half way up, there are two floors which are much larger than the others. This gives a wonderful visual relief to the facade -- a technique used by Le Corbusier when he inserted mainsonettes among the usual flats. What happened was this: (At least this was the story the US team was told) The buildings originally were designed for housing -- with relatively low ceilings. But when it was decided that the eight ministries were to be housed, either the architects or the respective ministers decided that the usual less-than-8-foot ceilings just would not do for the offices of ministers. So they made three floors into two -- creating a nice feature in what might have been a very monotonous building.

In terms of bold city planning, Kalinina Street in Moscow will hold its own with any street of any established city in the world.

BUILDING SYSTEMS

The USSR's greatest contribution to the building industry world is that it is providing housing for the masses with unusual speed and at a high level of technology. By our standards, the results are of low architectural quality; nevertheless, the USSR is solving her problems of housing her way and doing it to her satisfaction -- at least for the time being. Who can argue? But to say that the USSR is providing her people with high-quality, low-cost housing is simply not true. It is generally accepted now that industrialization of building is not a panacea for low cost housing. Most authorities in this country and in Great Britain believe that industrialization of the building process does lead to faster construction, but not necessarily to cheaper construction. In terms of an urban setting, there is no low-cost housing to any substantial degree. In the USSR, housing is neither low in cost nor high in quality by our standards. It is low-rent housing. Government subsidies see to that. Obviously money can be saved by omissions and by making things smaller. Russia does both. Regardless, the

Soviets should be credited with developing building systems which are advancements in technology and which keep on-site labor to a minimum.

The various Soviet systems must be classified as closed systems. In fact, they could not be more closed. A typical combine trust -- the combined organization for both manufacturing the concrete components and erecting the building to a turnkey situation -- generally builds only one "model" every three or four years. It is a stock plan house, pure and simple. Regardless of where the house is built, it is the same building. When 50 are built, each is the same height and each has exactly the same floor plan and external appearance. There is one variation: the length can be adjusted, within the limits of the elevator-stair module which generally serves four apartments on each floor. This one opportunity for variation is handy for planners, but offers virtually no variety of choice for architects. It is still the same building regardless of its length. But it is usually a building that the Soviets can manufacture and erect in a relatively short period of time. And they are getting by with it because there is a crying need for housing. When the users move in they are happy to have that roof over their heads. The problem of the inevitable complaints is delayed.

There are three basic building systems for housing:
Brick system - This was the conventional way of building houses which old Russia knew so well -- loadbearing brick walls. The system is still being used in modified forms. Sometimes the brick work is combined with either poured-in-place concrete floor slabs or precast slabs, generally the latter. Sometimes the brick is combined with either precast or poured-in-place concrete frame.
Panel system - This system provides houses of factory-made

large floor and wall panels, without the use of columns and beams. The system is particularly adapted to high-rise apartments having small rooms.

Box system - This system consists of boxes, sometimes referred to as 3-D units, which are in essence factory-made rooms which can be stacked on top of one another to form multistory houses.

The brick system seems to be on the decline. The panel system prevails at this time. The box system, although it has been used for relatively few buildings, is becoming more and more popular among the Soviet builders.

• The Brick System

Brick is the traditional material in Russia. As one Soviet official put it, "We know brick construction. We know how to use the material. It's not too expensive. The only trouble is that the brick system requires skilled masons who are few in number and a longer building time which we can't have." Another official, rationalizing why they were having such a hard time keeping the panel-built and box-built housing in good maintenance, said, "Our people simply do not know how to maintain these prefab buildings. If they were of brick, we would have no problems." Nevertheless, brick systems seem to be on their way out despite some attempts by research organizations, such as the Institute of Structural Design, to advance brick technology. So far there have been no brick-laying machines to revolutionize on-site construction. There have been attempts to build composite wall panels of brick and light-weight concrete at the factories. One such attempt was made with room-width panels about one third story in height.

One official said that experiments involving factory-made reinforced transverse brick panels had been conducted, but were not successful. "Our brick is not very strong. We dropped the project. Brick still must be hand laid, even at the factory." Another official was quoted by the interpreter as saying that "85 percent of the houses were prefabs and 15 percent brick." It was not clear whether or not this was in Moscow or in all of Russia. When asked why the Soviets were eliminating brick, the official said, "There are three reasons. First brick construction is not economical. Second, the system consumes too much labor. Third, in most sections of Russia it is a seasonal operation."

At the Glavmosstroy, the main office for design and construction for the city of Moscow, an official said, "Eighty-five percent of the houses are prefabricated; 15 percent are brick. We are doing our utmost to get away from brick all together."

In Leningrad at Glavleningradstroy one official said, "Our architects cannot do away with brick. Some sections of the city must be brick."

Unless there is advancement in brick technology, it looks as though the brick system will be obsolete, except for use in remodeling the old portions of the cities.

• The Panel System

At present the most popular system uses large prefab floor and wall panels put together to resemble egg crates and stacked up to 25 stories or more. In most cases the structure consists of both loadbearing transverse and longitudinal interior wall panels on top of precasts, sometimes prestressed floor slabs. Generally the exterior wall panels are non-loadbearing except perhaps to hold their own weight. The panel system is preferred because it provides for:

1. Relatively easy erection,
2. Less labor at both site and factory,

3. More opportunity for design freedom,
4. Easy transport to job site.

When asked what kind of prefab was the best and most economical up to 22 stories, one official answered, "Large panel construction." He cited the reasons given above, but also pointed out some of the shortcomings of panel construction. These are:

1. Welding the steel clips which tie the panels together. Also welding the reinforcing bars in the earthquake country. Welding is time consuming.
2. Grouting the joints is expensive and increases time on the site.
3. Integrating the lighting and mechanical is difficult particularly at the 90 degree connections.
4. 45 percent of cost is on site.

He had hopes of reducing the on-site labor to bring the cost figure at the site down to 35 percent or even as low as 30 percent of total cost.

The Soviets have demonstrated that they can stack these large panels in place with considerable speed. For a while our group was under the impression that a typical nine-story house could be erected in two months, which seemed a bit unreasonable. After considerable discussion, it was finally discovered that the factory officials were saying that the structural panels took about two months to be erected and it still was not quite clear whether this was in one, two, or three daily shifts.

The most reliable figures indicate that time required to erect a nine-story apartment house (15,000 to 20,000 cubic meters) designed with large panels is about nine months from site preparation to turnkey. It should be remembered, however, that combines or building trusts have a running start since they receive a year's advance notice of when and where the house will be built. Nevertheless, the panel system can be classified as a system which can go up in a hurry. In the experimental housing District No. 10, Moscow, where many different kinds of structural systems were used, the large panel system proved to be the most economical.

- The Box System

The Soviets seem to favor use of the box system for future housing. This system is similar to the one H.B. Zachry used in designing and building the Palacio del Rio Hotel in San Antonio for that city's HemisFair. The system is simply stacking prefab rooms together like a child would stack blocks. The result is "a house of boxes." One source said that the largest box being manufactured in the USSR is 6m x 3m x 2.8m; plans are to make them larger. Due to the weight of these "new bricks" transport and placement is a problem.

In 1958 the Soviets made an experimental mammoth box which was the width of an apartment building, weighing over 20 metric tons. (The boxes commonly used today weigh only 6.2 metric tons.) The Soviets carried this superbox all the way to East Germany without causing a crack. Propaganda-wise it was a great success. But from the standpoint of practicality this particular box was simply too big and weighed too much to transport economically, and was too difficult to handle on the job site with conventional cranes.

We hear arguments both for and against the box. One official said that the panels were much better. He conceded, however, that "the boxes are of the future." Apparently the box system does have a future. Recently a law was passed authorizing 27 factories throughout the USSR to make five-story and nine-story houses from "3-D components."

That puts the box "in."

One very enthusiastic proponent of the box system said, "Boxes are better than panels -- and cheaper. At present, the cost of labor to build a 3-D house is 2 1/2 percent less than that needed to build a panel house. We have a target to make it 10 percent cheaper using half the labor." He went on to say that the box system's total cost could be broken down to 15 percent labor, 60 percent materials, and 25 percent for other items such as transportation and equipment. It was not clear whether these figures represented a target or a fact.

Also it was never quite clear just how big the boxes were. Throughout the trip we had to play the "number game" without established rules. There was always a mix-up between "what we are doing" and "what we plan to do." One seemingly reliable source said that the experimental box building in Kiev had 3-D components which measured 4.7m x 3.1m x 2.7m. Officials at the Tzniepzilistcha in Moscow said they were involved with a 3-D unit which was 8m x 5m x 2.8m. Also at the same session there was mention of a box 11m x 3.5m x 2.8m. We took the latter to be a target module, but it might well have been a fact. Translation was quite often garbled.

• The Kiev Box

The great disadvantage of the box system is its inflexibility. Rooms can be just so large, and they can't be changed because the box walls are loadbearing. The experimental box system developed in Kiev was designed by an architect to give architects more latitude to create a variety of interior spaces. In essence, he busted the box. His unit is not a loadbearing box wall but is more like a structural frame cage. The vertical loads are carried at the heavily reinforced corners of the "box." This permits large openings in the walls when there is a need to open the interior space. Thus, the architects have much more freedom. The interior walls for example are only about 2 1/2 inches thick. In addition to the opportunity for a certain degree of open planning, large areas of the walls may be knocked out during renovation which in itself is a feature. The exterior walls are only 3 1/2 inches thick including insulation which also allows more fenestration opportunities. Such a structural system carries the advantages of both the box system and the structural frame. The experimental house, although relatively small -- about four stories -- had all of its boxes in place in ten days. One of the apartments had a large opening between two boxes -- the living room and supposedly the dinning room -- which gave a spacious appearance never found in the other box system apartments visited by the US team.

Another feature of the Kiev box system is that it provides the opportunity to have cantilever balconies, bay windows or extensions of certain interior spaces. The so-called box is factory-built without a bottom. Where extensions are desired, the precast floor slabs are simply made larger. "The Case of the Busted Box" opens up both figuratively and physically the highly restricted box system and offers many more architectural opportunities than either the panel system or the box system. It is a more complicated box and unquestionably more expensive. The problem of manufacturing the thin walls still exists and there is a "suspended ceiling" with which to contend, and size is still a restriction -- 4.7m x 3.1m x 2.7m. The "new" Kiev box is proposed to be larger, 5.8m x 3.4m x 2.7m.

THE ARGUMENT FOR PREFABRICATION

During a session at Tzniepzilistcha, the Central Scientific and Experimental Institute on Housing Problems located in Moscow, the following arguments in favor of prefabrication were presented by the Soviets:

1. Although prefab houses present a maintenance problem for the Soviets, they are committed to prefabrication and they believe within time they will be able to master the maintenance problem.

2. Because of the labor shortage, prefabrication is preferred since it is estimated that only one half the labor required for conventional construction is needed to build a prefab.

3. The housing shortage is still a great problem. Time is precious. "Prefabrication saves 45 percent of time of construction." It was not clear whether that is total time or on-the-site time, but we assumed the latter.

4. Factory building produces better quality buildings. "Because of our shortage of skilled workers, we can build a better house with machines," one of the factory managers pointed out.

5. Prefabrication also is credited with providing the Russians with 6 percent to 7 percent cheaper construction. Economy is very important since the USSR simply gives the houses to its people. There is no thought of amortization through rent. As already mentioned, the rent is so low it pays only half of the operation and maintenance costs.

6. Prefabrication is synonymous with precast or prestressed concrete. Steel or aluminum are not used except in rare situations where portability is required to some remote district.

COMBINES VS. SPECIALIZED TRUSTS

It was rather refreshing to hear disagreement among officials since Lenin's one-party system does not encourage this sort of thing. The canned, continual quotations of published statistics and quota attainment began to dull our senses after three or four days of bombardment. So when we heard a Soviet speak his personal opinion with conviction which conflicted with other opinions we became more sensitive to these people and they became more human to us.

One disagreement concerned whether or not the combine trust -- an organization which manufactures the concrete components and also erects the building -- should build the houses or whether specialized trusts should do the building. One official came out very strongly against combines. He said, "Let the builders build. A builder is always a builder. Let the manufacturer make things which he loves to do. He should not build." He considered himself a manufacturer and said, "We manufacture everything except bird's milk, and this includes machines to manufactures machines, not to mention large houses." He argued that when the manufacturer tried to build he would be tempted to put the "rejects" into the buildings so that the factory would show a greater profit. He emphasized, "We believe in specialization. Our job is to manufacture the elements. Let other specialists build the building. When we deliver an element to the job, it has to be good. If not, it will be rejected by the builder and that is the way it should be." His views are not shared by most of the other officials with whom we visited. Most of them believe that the combines solve the construction problem in a much more efficient manner than the specialized building trusts. The following reasons were given:

1. The combine system provides that total construction -- materials, manufacture of structural components,

erection, and finish -- be under one authority and offers a more direct approach.

2. The combine system encourages feedback so that continuous improvement in design and construction can be made.
3. The combine system is faster because there is less need for extensive communication where shared responsibility is required.
4. The combine system can produce economically because of standardization of building and construction methods.

To illustrate the point regarding feedback, consider the large housing project located on the right bank of the Neva River, District 13, Leningrad, House 39, which was visited by the US team. This unit had a very spacious stair well, but very small kitchens. Because of current pressure for larger kitchens the combine decided to "change the model" and make the kitchen larger. So, by the first of the year the factory will be retooled to produce a modified model which provides for larger kitchens at the expense of smaller stair wells. The building will remain the same length and square footage. To do this, one year and two months are required. This would be considered a major change. Minor changes such as improving a connection detail or moving an electrical outlet or changing the color of trim or pattern of wallpaper obviously would not take so long.

At the main Gosstroy in Moscow, the Soviet central bureau of design and construction, one high official said, "We have found that the best system is combining the manufacturers and the erectors."

CONCERNING MISCELLANY

As already pointed out, the Soviets do a magnificent job of manufacturing and erecting the large concrete components, but find it most difficult to manage the small things; particularly the details concerning finishing and integration of electrical wiring, fixtures, heating and plumbing. However, the US group did find some most interesting and innovative details. Some of these, plus other observations, follow:

- The University of Moscow, a huge monumental palace, has 20,000 students, 75 percent of whom are women. Six thousand live in dormitories. There are no architectural or engineering students; they generally go to technological institutes in which the number of women students is about equal to the number of men students. The "high school" students must pass a four-day examination for university admission and a seven-day examination for admission to the technological institutes.
- All of Moscow is heated with central heat generated from 14 boiler plants. These plants supply both electricity and hot water for heating.
- All house factories operate 24 hours a day.
- Brickwork in Moscow is a seasonal, six-month operation -- another reason for prefabrication.
- Generally electrical wiring is put in the concrete components without conduits.
- By code every room in a housing project must have not less than three hours of sunshine per day during March. It is questionable, however, whether the rule means anything. Certainly the sun in Moscow is precious. In Tashkent "it is an enemy" as one Uzbek so aptly put it.

- We were told that there is a shortage of architects -- a reason for the necessity of standard designs. On a per capita basis, the USSR has fewer than one sixth the number of architects that Bulgaria has, and one tenth the number England has.

- The factory-made, mass-produced houses seem to be growing taller and taller. At first they were only five stories, then, because of the economies of elevators, the jump was made to nine stories, which now seems to be a minimum in Moscow. High-rise apartment blocks go up in increments of 9, 12, 16, and 25 stories. Houses over 30 stories are anticipated.

- The Soviets are experts on fast curing concrete using hot water and electrical heat.

- They build superb, long-span, prestressed concrete trusses.

- One of the most daringly engineered concrete structures we saw, a beautiful sculpture in its own right, was the Moscow TV Center Tower, 530 meters high, about twice as high as San Antonio's HemisFair Tower.

- Wood sash was used in all houses. The argument for this was that wood is better for low temperatures, and there is plenty of wood. Steel and aluminum sash, however, was used in some hotels and shops.

- Very little concrete block is used.

- Glass, particularly the large sheets, appears to be far below the quality of plate glass in the US -- like a poor grade of crystal sheets.

- Construction cost goes up every year just as in US. Why? We were told the accelerating cost was caused by: 1) demands relating to comfort of living; 2) increase in luxury relating to space; 3) salary of workers going up. In other words, the Russians want better things and architectural design will have to become increasingly more important.

- In Leningrad we were told that the time required from city approval of funds to completion of a house was from 4 to 4 1/2 years, including 1 to 1 1/2 years, on the average, for construction.

- Double glazing is used throughout northern Russia. The quest bedrooms of the Hotel Sovietskaya in Leningrad had a system of miniature venetian blinds installed in the sash between the two sheets of glass.

- Leningrad codes require that in a typical housing project there be no more than 3,500 people for each hectare up to 5 stories; above 5 stories 4,000 people.

- The following distribution of spaces was given to us for a typical 216-apartment house in Leningrad:

one-room apartments*- 10 to 12 percent
two-room apartments - 30 percent
three-room apartments - 48 to 50 percent
four-room apartments - 10 percent

The sizes and capacity are:

one-room apartment -	16 sq. meter living area**
	32 sq. meter gross area
	capacity: two people
two-room apartment -	28 sq. meter living area
	48 sq. meter gross area
	capacity: three people
three-room apartment -	45 sq. meter living area
	64 sq. meter gross area
	capacity: 4 to 5 people
four-room apartment -	55 sq. meter living area
	71 sq. meter gross area
	capacity: 5 to 6 people

* Number of rooms means living-room plus bedroom; thus, a one room apartment is equivalent to an efficiency apartment in US.

**"Living area" does not include bath, kitchen or halls.

- The question of just how to tie the concrete panels together structurally and during the erection is a universal problem. Holding the panels in place during the grouting procedures is a problem for the erectors. Waterproofing the joints is another tough problem, and the esthetic aspects of the connections is still another. Combine No. 2 Leningrad, had some ingenious solutions, particularly for the problem of connecting the panels until the grouting had set. It developed a steel sprocket link, very much like a screen door hook and eye, which holds the panels in place temporarily until the joints are grouted. After the grouting sets, the steel serves as reinforcement to strengthen the corners. There is no attempt to hide the joints between the panels and an inch or so space is deliberately left to articulate the connections. In this groove a rubber-like waterproof gasket is installed. Esthetically this frank expression of the panels is far more successful than attempts to make the joints flush, which generally result in indecisive form.

- The April 1966 earthquake in Tashkent stimulated fresh approaches to solving the connection problem of structural prefab components. One solution is the use of the volumetric cross (similar to the "column tree" unit used in Mexico City). Another is doubling the amount of reinforcement and welding all connections.

- In Tashkent one combine was building a house with radiant heating pipe installed in the reinforcing "cage" just prior to the concrete pour -- a natural technique for precast slabs and hot water heating. The same combine developed a clever way of creating electrical tunnels in wall and floor slabs which took the place of conduits. Rubber forms with metal inserts were placed in the "cage"; after the concrete set the metal was pulled out enabling the rubber hose-like form to be removed easily.

- One Tashkent factory built its large panels with saw-tooth edges to provide better bonding of the panels after they were grouted together on the site.

- More small things concerning the Soviet hotels: a) In one hotel in which the group stayed, to call from one room to another required dialing 7 digits: in others, where the number of digits required for dialing was the same as the number of digits in the room number, the room and the dialing number did not match; b) where there were two opposite banks of elevators one had to press a button on each side; c) in two hotels, one had to go outdoors to get to the main dining hall; d) the most ridiculous of all (surely there was a renovation program causing this) was in Tashkent. If one wanted to go to the roof garden night club, he had to go through the restaurant which was outside and then up the freight elevator near the kitchen.

THE SOVIETS' CHALLENGE

The Soviets, at least those at the highest levels of authority, realize the shortcomings of their attempts to provide good dwellings for the masses. Various officials pointed out the need for improving the quality in both the architectural fabric and space. One said, "We need greater versatility. At present each series (factory-built models) has its own number and characteristics of elements (components). Because of this, we build houses that are too monotonous, too dreary."

He did not say it, but we felt that all officials realized their situation -- factory produced mass housing has slowed down advancement in architecture. The lack of quality carries with it the lack of architecture. If architecture is defined as the aura or "feeling" that transcends mere shelter to a higher level where man is inspired, stimulated and sensitized by his man-made environment, then most of the houses we saw lacked architecture. Architecture is shelter engineering plus. It is that plus something that radiates architecture. In Russia it is the plus that is lacking in mass housing. It is lacking because architects have not grown either in number or in professional development. One of our group said, "Working as an architect in Russia is like trying to set a track record running in molasses. It takes so long to improve the model." Although most officials said to change the series required 3 1/2 to 5 years, one Soviet made a side remark that "5 to 10 is more realistic."

In any case, as the situation stands now, the following is apparent:

1. The Soviets are research-minded and are advancing building technology.

2. They can manufacture the concrete components with efficiency and effectiveness. The factories are great.

3. They can erect these prefab units with considerable speed.

4. They can build economically, but the relative cost is not much lower than comparable construction in the US, if there is any. However, they can do it faster and are not hampered by seasons.

5. The housing is poorly finished and maintained. The Soviets just can't seem to finish the houses with any degree of polish; nor can they maintain them.

6. The plans for typical dwellings are questionable. It is understandable that because of economy the rooms are too small, but neither standardization nor technology should impose upon users and architects the unreasonable requirement that the living rooms should be the same size as the bedrooms -- or that dwellings be chopped up like egg crates. Architects need more freedom to meet living demands, particularly to make use of the open planning concept which enriches living, especially in small spaces.

7. There are some good signs. The Soviets, in addition to starting the catalog system are toying with the idea of going to a dwelling-size structural module in which the architect, and even more important, the tenant, can subdivide the large space into smaller spaces of varying sizes to meet specific family needs. This is a real bright spot.

8. The Soviets can handle the big things with a high degree of effectiveness -- manufacturing large boxes and stacking them 20 to 30 stories high is no problem. It is the details, such as window sills, floors, walls and ceiling connections, and the integration of wiring, heating, and plumbing that seem so difficult for them to do.

9. From the standpoint of architectural quality, the factories are excellent and the "unique" buildings are generally good. The architectural quality of housing is poor. In fact, to some members of the US team many of the houses were architectureless -- mere shelter. In Russia this is a fact: The process is better than the product -- the factories which make the houses are far better than the houses.

The Russians know these things. At the last wrap-up meeting in the main office of Gosstroy, the presiding official said, "Where there are too many buildings of the same type there is monotony. It is the government decision to provide more factories which will be more flexible -- to manufacture buildings of different types. Another target is to create factories to build components which are interchangeable with the components manufactured by other factories. We want to design houses making use of a catalog of components which will allow us to give our people dwellings that vary in size, height, and character."

There seems to be an innate desire toward individualism despite the standardization and regimentation in Russia. This desire is evident when tenants rearrange and decorate their balconies; when either a group of tenants or the architects decide on different colors for the end walls of the same type houses in one discrict; when the tenant moves in and changes the wallpaper; and when one official in the Republic of Ukraine says, "We want Kiev to be Kiev."

LAW

REPORT

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USER NEEDS

Providing for "user needs" appears to have but a superficial effect on the design of dwelling space. This becomes evident when observations are made concerning the following provisions:

- Illumination Levels

Generally, the current housing design incorporates large glass areas in exterior walls which in Moscow was related to a "code" requirement for three hours of sun each day in each apartment at the time of the vernal equinox. Since buildings were oriented to all points of the compass, this code requirement was not always met and the large glass areas were related more to developments in Western architecture than to user needs.

• Food Preparation and Storage

The first housing project we visited in Moscow was to have a central kitchen and a small dining area, although a kitchen sink was to be provided in each apartment. Elsewhere, all housing units we visited had kitchen areas. Apparently only a sink is furnished in the apartment; stoves and refrigerators are furnished by the tenant. We gathered that the community kitchen and dining concepts had not been favorably received by tenants.

• Heating and Ventilating

While standard designs were modified for local conditions, apartment heating systems amounted to only crude radiators of finned pipe or 1920 Western-vintage cast iron models controlled by a hand operated valve. In Tashkent, we saw a building that was to be partially air-conditioned. That part of the building having apartments without balconies and cross ventilation would be air-conditioned, while the other portion would not. Tashkent summer temperatures may reach 115°F. Most bathrooms and water closets had interior locations and had exhaust ventilation systems of minimal effectiveness.

• Space Requirements

The nationwide "norm" or "law" is nine (9) square meters of net living area* per person. Our hosts stated that they knew that this was low by Western standards and suggested that this figure was to be raised to 15 square meters per person. While I do not know what criteria were used to establish the 9 square meter figure, I doubt that the user influenced its determination.

* Does not include bath, kitchen or halls.

BUILDING SYSTEMS

The standardized designs lend themselves to integration of mechanical and electrical subsystems. While some subsystems are developed for installation in the factory, this was not true in all cases. Present factories and sites visited indicated that the current trend is toward more factory installation of mechanical and electrical subsystems. Plumbing for toilet rooms seemed to be the most highly integrated. A structurally complete toilet room assembly with floor, surrounding walls with doorways for the bath, a separate water closet riser and roughing connections was cast in one piece at a factory in Kiev. Cast at the factory are floor and wall panels with radiant heating piping and electrical wiring, leaving only risers and mains to be be installed at the site. Most of the work that the US team observed, however, required the mechanical and electrical installation to be made at the site. Only conduit or openings were factory-cast to accommodate the wiring and piping.

MECHANICAL AND ELECTRICAL SYSTEMS

We requested diagrams and descriptions of the following systems provided for apartment buildings: plumbing, heating, ventilating, air-conditioning, vertical transportation, electrical power and light and trash disposal. Such information was anticipated to be rather voluminous and beyond development during the brief discussion periods available. We did not receive such information prior to our departure, and it has not yet been furnished, but perhaps our questions were actually answered -- not in the requested detail, but simply through exposure during our visits to the construction sites, factories and our hotel facilities.

- Plumbing

The single pipe combination waste and vent system, with an open relief vent at each floor, was typical. Piping for a toilet room and a kitchen sink was being prefabricated and cast in toilet room sections at the factory. Cast iron pipes with sulfur joints were used for waste lines while water piping was steel and hot water piping galvanized. Toilet rooms were located to the interior and were provided with an exhaust or ventilating air outlet. The vent duct and room outlet were also cast into the wall sections.

- Heating

The terminal heating units in the apartments were either crude finned pipe radiators or cast iron units of US 1920 vintage. The heat source was hot water supplied from the central distribution system. While many older buildings apparently are not connected to the central heating distribution system, new facilities are. Hot water for space heating and domestic hot water is distributed from the Thermal-Electric Plants or in some cases, Thermal (heating only) Plants. I understand that these plants are rather sophisticated while the individual apartment control is a simple hand operated control valve. A minimal amount of heating piping was prefabricated and cast in panels at the factory; most was installed at the site. Factory-cast piping consisted primarily of coils for radiant heating or cooling systems. Mains and radiator connections were installed at the site.

- Ventilating and Air-conditioning

Residential construction incorporated few mechanical ventilation facilities. Interior toilet rooms have exhaust systems, but window ventilation is the standard for peripheral rooms. Space in new commercial buildings used for public assembly (hotel lobbies, restaurants, etc.,) is ventialted with mechanical systems, but refrigeration equipment for mechanical cooling is not extensively used. In Tashkent, we were shown the exterior of an apartment under construction which was to be partially air-conditioned. That half of the building which did not have "exposure" to natural ventilation would be cooled by a combination air system and radiant cooling in the floor and ceiling (same concrete deck - the floor being the ceiling of the apartment below). The "cold generator" or chiller was an absorption refrigeration machine which was supplied heat from the central heating plant system. This system is apparently a concession to the local summer weather conditions.

• Vertical Transportation

Elevators, or lifts, the more descriptive designation for the residential elevators, are provided for buildings with more than four floors. The norm is one lift for 5 to 9 floors, two lifts for 9 to 16 floors and three lifts for over 16 floors. The method of determining these criteria is unknown. In a nine-floor building the lift is located at a stair core serving two to four apartments, depending upon the number of rooms in each, on every floor. Economics of a lift installation are such that only every other intermediate landing between floors is served, starting with the landing between the fourth and fifth floors. Thus, tenants walk up the lower three floors and others go up or down a half-floor. One sixteen floor high-rise in Moscow had a central corridor with apartments on each side and two elevators which were centrally located and stopped at each floor. We saw too few buildings to judge whether this was design flexibility or merely a different standard apartment model.

• Electrical Power and Light

Electric facilities provided appeared to be minimal, generally consisting of one baseboard receptacle per room and one ceiling outlet for lighting. Aluminum wire, apparently insulated with P.V.C., was frequently seen cast in the concrete walls or floors, or imbedded with spackle or grout in grooves cast or cut in the concrete panel surfaces without mechanical protection. Plastic conduit was also observed, as well as conduit holes in concrete panels which were left by plastic tubing which was pulled after the concrete had set. The bulk of the wiring installation seems to be done at the site. Although workmanship seemed adequate, the grounding system seemed completely inadequate for even normal safety.

• Trash Disposal

Each apartment building visited had a "prefabricated" trash chute. It seemed to be actually nothing more than reinforced concrete pipe with a special section to accommodate the loading door. I did not see a receptacle or container at the bottom of the chute but was told that trash was received in a container which was hauled away and emptied. We were also told that trash was shredded and compacted, but no equipment for either process was noted. In part, our whole experience in Russia was haunted by the minute quantity of trash or waste in Soviet society. I am inclined to believe the volume of waste collected from an apartment complex is of little consequence.

SUMMARY

Since the preceding comments were developed from observations and from brief answers to specific questions, they are tantamount to an opinion as are the following:

While considerable effort has gone into the development of industrializing the structure - floors and walls - there is no evidence that the same effort has gone into the mechanical and electrical fields. These fields exhibit only economy of material - not of labor. The plumbing, while installed as well as fabricated in the factory, could be installed in the field. This would eliminate some of the rather tricky and expensive connections which are now necessary. A back vent could be added to improve the sanitary conditions also. Wiring could be almost completely installed in the factory by methods other than directly casting the wire in the concrete, and in a manner permitting easy service and maintenance, but there would be an increase in the amount of material used. The quality of elevators could be improved; but since they must be installed in the field, improvements would increase site labor. Controls, however, can be preassembled and wired. Air-conditioning for residences is actually only needed in an area such as Tashkent. Mechanical ventilation, except for toilet rooms, is not a requirement for an apartment with windows.

Overall, improvement in the quality of finish materials, systems and installation is required. Work which is now installed at the site could be installed at the factory and vice versa. The mechanical and electrical systems installed are so simple as to be relatively long-lived and maintenance free, (except the elevators) and none of this should be lost through the improvement in workmanship and quality control which is available through factory installation.

MAST

REPORT

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COST CONTROLS

It appears that the USSR's normal practice is to set estimated costs about 12 to 15% above current costs; if production is normal, the producing combine or trust earns a portion of the sum remaining over actual costs as a bonus which is used in providing amenities for the workers and some minor improvements in the plant.

In the event of a construction casualty such as a fire or a failure of some structural element, it was admitted that additional financial support was forthcoming to the combine or trust when required.

The system of cost controls was based primarily on the system of bonuses which extends to all workers in the organization. Very extensive production records were kept and could be quoted by all involved, but it was not readily apparent as to how they located weak points in the overall operation except through comparisons with similar organizations.

One of their most difficult problems rests in the fact that workers in construction are not as highly paid as many other factory workers with the result that the highly skilled leave the field for other industries.

CONSTRUCTION PROCESS

It has become generally recognized in the United States that the primary function of general contractors is the management of the construction process. What may not be generally understood is that the proliferation of materials and processes together with the full employment of manpower experienced in the United States in recent years has made effective management of construction an extremely difficult and sophisticated endeavor.

In comparison, the USSR has simplified the construction process by reducing the number of alternatives. For example, in urban housing relatively few designs of apartments are being constructed. Looking further into the design of one of these apartments, it is ascertained that only minimum amenities are offered, including minimum kitchens and bathrooms, little or no closet space, minimum electrical service, elementary heating of living rooms (none in bedrooms) and no air-conditioning. These apartments have only standardized sizes of windows and doors, and floor and wall finishes are limited to a few choices.

Only by these mandatory limits on unit types has the USSR been able to enjoy large markets and to justify the capital investment in its plants. Such plants, in turn, are needed if large numbers of people are to be housed and if a complete breakdown of management is to be averted. Even so the system appears to be badly strained.

• Management Systems--Trusts and Combines

Gosstroy is using two management systems for urban housing construction. In one system it depends on "trusts" that consist of construction organizations or firms which in US terminology include both general contractors and subcontractors; these are called "building trusts" and "specialized trusts." The building trusts perform the general trades work on the superstructure only and the specialized trusts perform the balance of the work including the site work, the foundations, the plumbing (sanitary), the electrical work, and the painting. Under either system, about 10% of the total personnel is assigned to management and supervisory positions. Most of the construction machinery is owned by several special machinery trusts and rented to the building or specialized trust requiring its use.

In a newer system, main reliance is placed on the "combine." This is a combination of the producing factory and the building trust and undoubtedly has come into existence to place more of the management function within a single construction entity. The combine still employs the specialized trusts for part of the on-site work.

This system is not universally accepted. One of the repeated arguments against it is that the building trust, which is in fact an extension of the factory, has the responsibility for rejecting inferior products which happen to be its own products.

• Structural Systems -- Panels and Boxes

The top echelons of Gosstroy have been recommending the general use of the panel approach to the mass production of housing. In this structural system, the walls and floors of each room are produced in a factory as single prefabricated units which are called panels. This is presently the best solution to their housing problem and results in about 55% of the total labor being performed in the factory and 45% on the site. The Soviets estimate they can move panels a maximum of 150 km (93 miles) economically from factory to building site.

Gosstroy is now recommending the use of the box which is the complete 3-dimensional unit cast in the factory. It is estimated that this would result in about 70 to 75% of the total labor being performed in the factory, thus reducing the site labor to 30 to 25% of the total. The US team made repeated efforts to learn how the transport and handling of these large and heavy units were accomplished but received no conclusive answers.

The Soviets stated that they were considering two maximum three dimensional targets: the first, a box measuring 3.6 m X 11 m X 3.3 m (11.81 ft X 36.09 ft X 10.83 ft) and the second, a box measuring 5 m X 8 m X 3.3 m (16.41 ft X 26.25 ft X 10.83 ft). These would produce a maximum weight of about 25 metric tons (27.5 tons). The Soviets claimed an ability to construct trailers to transport these boxes but answers were inconclusive as to whether legal and actual road clearances, bridge designs and underpass clearances would permit movement of such boxes. In addition, the usual construction-site crane would have to be replaced by a much larger capacity crane to lift these boxes into position in the multistory apartment buildings. For example, in Moscow they are establishing the use of a minimum of 9-story buildings, with some 12-, some 16-, and a maximum of 25-story buildings. A major change in equipment would be required to position units for such buildings.

The state committee on architecture and civil engineering for Gosstroy is Gosgrazhdanstroy. This agency does the general planning for Gosstroy, handles the research and is responsible for individual unique designs; about one-third of the staff is assigned to each of the functions named.

They work out technical policies and develop the standard designs used for most apartment construction. Their research group has become deeply involved in the unification of building elements by building types rather than overall. They have already submitted separate proposals to cover schools; theaters; commercial buildings; an apartment group that may also be used for hotels and nursing units; and a group for technical training and laboratories. This should be an important development for the future.

EQUIPMENT AND MACHINES

The factory equipment represents a tremendous capital investment and has been developed by the Soviet authorities by using equipment from all of Europe as well as by research in its own facilities. It is impressive and has been developed primarily to increase production while using relatively unskilled labor. The larger portion of the labor employed has to be taught only one specific task and so can become proficient in a relatively short period of time.

The equipment and machines observed on construction sites should generally be classified as good but the impression was gained that much of it was not as sophisticated as it might be. It appears that the Soviets, once having hit on a workable solution for a particular piece of equipment, are slow to make meaningful changes.

Many idle tower cranes were observed during the travels of the US team. It was assumed that these cranes were being under-utilized because of the great number of buildings under construction and because the producing factories were simply unable to turn out products to keep all projects underway at the same time. It is quite likely, however, that raw materials were insufficient to meet the demand.

FROM FACTORY TO SITE

The US team personnaly observed the movement of panels from factory to apartment site. These panels were moved on tractor-drawn trailers with fixed A-frames against which the panels were placed. These were loaded in the factory storage yards by some type of overhead crane and unloaded on the site by a tower crane that placed them directly on the apartment building.

Some new trailers were observed at Factory No. 2 of the Combine DSK-1 in Tashkent and upon inspection it was noted they were of French manufacture.

The cost of transport is variable, but information received at Kiev indicated that the cost of transport was estimated at 4 kopecks per metric ton per kilometer plus 2 kopecks for loading and unloading. This is based on tractor trailer rental of 18 to 20 rubles per day, including driver. The distance traveled from the factory to the individual site would thus determine the cost of transport if the unit was quickly loaded and unloaded.

At Tashkent it was suggested that the average cost of transport was about 3% of the total construction cost.

ORLEBEKE

REPORT

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THE SOVIET APPROACH TO HOUSING

• Need for Industrialized Building

In the years between 1923 and 1950, the average urban per capita living space in the USSR fell from 6.45 square meters to 4.67 square meters. Thus, the most compelling consumer need in Soviet housing has been the need for living space itself. Population growth, the migration of population from rural to urban areas, and decades of neglect of housing needs by Soviet political leadership combined to produce in the 1950's very nearly intolerable conditions of overcrowding, poor sanitation and increasingly rapid deterioration.

In response to mounting social and political pressure for more housing, the Soviet Union has developed industrialized housing systems capable of producing housing on a volume basis. This means to the Soviet consumer that his most elementary housing need -- private living quarters for himself and his family -- is being responded to by his government.

The problem of net living space* itself is far from solved. The current living space "norm" is 9 square meters per person, but actual conditions probably are around 7 square meters. Waiting periods for separate apartments are said to average two and half years; and according to Deputy Chairman Ganichev of Gosstroy, the Soviet Union hopes to be able to assure immediate availability of separate apartments for newlyweds by 1980. However, while industrialized housing in the last decade has done little more than enable the Soviets to keep pace with urban growth, it has clearly demonstrated that the technological and production potential -- if mobilized -- has the capability of meeting the Soviet Union's long-term housing needs.

The commitment to mobilize this potential evidently exists. The USSR, we were told, plans to build by 1974 some 28 factories throughout the country capable of producing a variety of standardized housing components and three-dimensional modules.

• Quality of Housing

Although the living space shortage continues to persist, the progress in industrialized housing production has permitted Soviet housing officials to give increasing attention to consumer needs beyond sheer space. Such attention was overdue, for the astonishing pace of Soviet housing production was not achieved without sacrifice of quality, esthetics, and well-planned community development.

*Net living space equals area of living room and bedrooms -- excludes inside hall, kitchen and bathroom.

Except for the most recent construction, residential development in Soviet cities is typified by mile after mile of drab high-rise apartment buildings erected with little apparent concern either for the esthetic appeal of the buildings themselves or their surroundings. The interiors of these buildings are frequently marred by poor fittings, chipped concrete and tile, stains and other unsightly features. In addition, more serious visible structural flaws are not uncommon. The grounds around and between the buildings are characteristically marked with random patches of grass and weeds and a few scraggly bushes and trees. Children's play areas are frequently unattractive and the equipment poorly maintained.

Although our Soviet hosts generally avoided showing us the interior of occupied apartments, we could gather from informal conversations that the quality of workmanship and materials on the inside was no better than that on the outside. We know from published studies and articles, as well as from our own limited observations, that there are frequent breakdowns in the plumbing and electrical systems, that replacement parts are hard to get, and that maintenance services generally are extremely slow and unreliable. What every traveler to the Soviet Union learns, the Soviet citizen lives with every day: doors, windows and sometimes walls often do not fit properly; and anything mechanical either does not work or has a tendency to come apart in one's hands.

Soviet officials were reluctant to provide detailed information concerning the extent of problems of quality and maintenance. They did, however, talk freely in general terms about the need to improve quality. It was clear that they have been under steadily increasing pressure, both from tenants and from the Communist Party Central Committee, to give greater attention to the quality of construction and general attractiveness of housing developments.

Increased attention to quality and esthetics can be readily observed by comparing apartments recently or currently under construction with those built five to ten years ago. The contrast between new and "old" is particularly marked in Leningrad and Kiev, where the local housing agencies are now using tile facings, murals, specially designed building entrances, and other decorative features which add significantly to the esthetic appeal of the buildings. Soviet officials acknowledge that these improvements add to the construction cost without adding to the purely structural quality of a building, but it is evident that they (and their tenants) believe the expense is well worth it.

In addition to improving the exteriors of buildings proper, the Soviets are using various techniques to avoid the visual monotony of their earlier industrialized housing developments. These techniques include varying the facings of the buildings which make up the development, varying the heights of buildings, and giving increased attention to landscaping, layout of walkways and recreational areas for children.

DETERMINING USER NEEDS

In each city visited, our delegation inquired as to the specific systematic methods used to obtain the opinions of Soviet citizens regarding housing design improvements. We were informed in Moscow (the Central Research Institute for Economic Planning of Housing Construction) that there were two principal methods for gathering such data: Personal interviews and questionnaires. Each year, students conduct 50,000 interviews with tenants on all aspects of housing design. In addition, 100,000 questionnaires are distributed to a sample of tenants and the results are analyzed by computer for use in future housing designs. Soviet officials in each city expressed general awareness of these surveys, but we were unable to gauge their influence on current construction.

We were, however, able to obtain a sample questionnaire dated 1966 used by the Leningrad Zonal Scientific Research and Design Institute for Standard and Experimental Design of Public and Residential Buildings.

The cover note on the questionnaire read as follows:

> "Dear Comrade,
> Improvement of living conditions in the Kraynyy Sever (Extreme North) regions is one of the most important problems facing us in the next few years. To solve this problem, we have to build many new residential and public buildings which would satisfy the working, living and recreational requirements of the Northern towns and settlements.
>
> The attached questionnaire is designed to reveal those requirements. The information, obtained from the questionnaire, will be used to help architects and engineers to consider more thoroughly the needs of the population and to design dwelling houses, nurseries, kindergartens, schools, and other public buildings, and also towns and settlements of the North in a way which would best satisfy the needs of the Northerners concerning their housing and everyday services, cultural and instructive activities, sports and peaceful relaxation.
>
> Please write your answers in the spaces provided for

this purpose. For those questions in which you have a multiple choice of answers, please underline those which coincide with your opinion."*

The questionnaire itself contains 33 questions. By far the most fascinating characteristic of the questionnaire is that there is not a single question about any feature of a living unit proper. The respondent has no place to register his views on relative room size, kitchens, bathrooms, storage space, decorations, or any other feature.

The questions which are included seem aimed at providing a picture of the respondent's total life style -- the way he spends his time, and the way he would like to spend his time. Thus, there are questions on the time he spends studying, going to theaters and concerts, going to night clubs and restaurants, participating in sports, pursuing hobbies and doing "social work." In each case, there is a companion question on how much time the respondent would like to spend if circumstances permitted.

The respondent is also asked what months of the year he considers desirable for various kinds of outdoor sports (swimming, tennis, volleyball, skating, hockey) and other outdoor activities (picnics and walks). Another question is: "Where do you usually take your children out for a walk when the weather permits?"

We have no way of knowing whether this particular questionnaire is typical of those used to measure consumer needs, or whether it is merely one of a number of different questionnaire schedules in use. Even so, the fact that there are no questions at all directly bearing on the dwelling unit itself suggests that the dwelling unit is

*The entire questionnaire is Appendix C of this document.

looked upon as a rather incidental part of the individual family's total living experience and environment. In this context, the dwelling itself is a utilitarian necessity for the family which fades in importance in comparison to the social and communal life of the family outside the home.

Insofar as this questionnaire, and others like it, are structured to elicit information and attitudes on general life style rather than on specific construction and design features, it seems fair to conclude that pressure for improvements in quality and design will be somewhat blunted.

Whether this is the result of a conscious decision by Soviet policymakers is difficult to say. They undoubtedly believe that they are asking the right questions about the future of Soviet housing, and perhaps they are.

But, if in the process, the Soviets continue to build millions of industrialized housing units without stepping up still further their efforts to improve quality, they will be faced in too few years with a dual set of painful problems. The first is a building maintenance problem of very nearly unmanageable scope; and the second, an aroused public opinion demanding radical corrective action.

WATSTEIN

REPORT

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WINTER CONSTRUCTION

Enclosures are used in winter construction only to a minor extent. The predominant methods of erecting masonry during the winter are the following:

1. The fresh masonry is permitted to freeze and is presumed to harden during the subsequent natural period of thawing; the loss of strength caused by the adverse curing conditions is taken into account in the design of the structure.

2. Same as above, except that artificial heat is supplied to the frozen masonry for a period necessary to obtain initial set of the mortar.

3. Same as above, with the addition of chemical admixtures for accelerating the setting of cement.

Masonry erected in seismic zones (intensity of 9 on Soviet scale) must develop a minimum of 20% of its design strength prior to freezing. This must be achieved by artificial heating methods, including heated enclosures.

FIRE SAFETY AND CODES

The combustion characteristics of the materials in the apartments appear to be similar to those in the US. The occupied apartments we visited in Moscow (these were occupied by professional people), and the apartments at a collective farm, Kodaky, near Kiev, appeared to contain a generous assortment of wooden furniture and the usual curtains on the windows. As often as not, the flooring material was hardwood parquet.

TESTS FOR SEISMIC DESIGN

Full scale tests, both static and dynamic, are being planned by the Uzbekistan Gosstroy in the city of Tashkent. The US Delegation was informed by A. T. Shakhov, Chairman of Uzbekistan Gosstroy, that an experiment involving full-scale structures is in progress. An explosion involving 2,000 tons of TNT will be set off at a depth of 75 meters at a distance of 135 meters from the center of the experimental structures. This will simulate an earthquake having an intensity of 9 on the Soviet scale. The experiment, to be carried out sometime in 1970, will enable the code authorities in the Soviet Union to update their codes on seismic design.

PRECAST/PRESTRESSED CONCRETE

The Soviet standard for reinforced concrete, prestressed and nonprestressed, specifies that the design be based on the ultimate strengths of the members. However, the ultimate load carrying capacity must be determined by using the following three criteria:

1. Ultimate capacity based on the ultimate strength and stability--applicable to all constructions.
2. Limiting deformation--applicable to constructions in which excessive deformations may limit their usefulness.
3. Formation of cracks--applicable to constructions in which the width of cracks must be limited.

The problem of redistribution of stresses in statically indeterminate structures is being actively investigated in the USSR, but the development of the theory of redistribution of moments is not yet sufficiently advanced to warrant being incorporated in the Soviet standards for reinforced concrete. However, a tentative "Instruction for the Design of Statically Indeterminate Reinforced Concrete Constructions Taking Into Account Redistribution of Stresses" was published by Gosstroy in 1961. This information is given by S. M. Krylov in a comprehensive study entitled "Redistribution of Stresses In Statically Indeterminate Reinforced Concrete Constructions," published by Gosstroy in 1964.

The Soviet standard for the design of concrete and reinforced concrete structures, NiTU 123-55, specifies the following concrete strengths: 50, 75, 100, 150, 200, 300, 400, 500 and 600 kg/cm^2; these are the strengths determined with 20 cm cubes tested at 28 days. The corresponding strengths in English units are 710, 1070, 1420, 2130, 2840, 4260, 5680, 7110 and 8530 psi. We must keep in mind, however, that our standard compressive specimens are 6 by 12-in cylinders which give strengths about 20% less than 20 cm cubes.

The grades of steel specified for reinforced concrete are given in the following table:

Description of Steel	Specified Minimum Yield Strength	
	kg/cm^2	psi
Hot rolled plain bars Grade St O	1700	24,200
Same as above, Grade St 3	2100	29,800
Hot rolled plain bars of Grade St O subjected to cold working	2100	29,800
Same as above, Grade St 3	2500	35,500
Hot rolled deformed bars Grade St 5	2400	34,100
Same as above, Grade 25GS	3400	48,300
Cold drawn wire reinforcement with diameter up to 5.5 mm	4500	64,000
Same as above, for diameters of 6 to 10 mm	3600	51,200
Cold stretched deformed bars of Grade St O and St 3	3600	51,200

STRUCTURAL SYSTEMS OTHER THAN CONCRETE

- Masonry

Although the Soviet standard for plain and reinforced masonry, SNip II-B.2-62, has special provisions for vibrated brick panels and brick-block assemblies, we have not seen any prefabricated masonry panels in any of our inspection trips to building sites. Although a large number of high-rise bearing wall buildings are under construction, all the projects we visited indicate that, without exception, the masonry is conventionally laid brickwork.

This observation was confirmed in a meeting with Mr. S. A. Sementsov and Mr. V. A. Kameiko at the Central Masonry Research Laboratory in Moscow. They stated that for all practical purposes only conventionally laid masonry is being used. It is more economical and lends itself to more flexibility in design and architectural treatment than prefabricated panels.

Maximum allowable heights for loadbearing masonry walls are as follows:

1. For unreinforced masonry, the Soviet Masonry Code NiTu 120-55 limits the ratio of height to thickness in accordance with the values given in the following table:

Table 1

Compressive strength of mortar, psi	Limiting ratios of height to thickness
710 or greater	25
355	22
142	20

2. For reinforced masonry, the values in Table 1 may be increased by 20% when the longitudinal reinforcement is in one direction only; when the reinforcement is in two directions, the ratios in Table 1 may be increased by 30%.

• Plastics and Aluminum

We were informed that neither plastics nor aluminum is being used structurally at the present time, although both materials are being used as trim and for architectural treatment. We were informed that the sash in the imposing high-rise office buildings in the New Arbat area were of aluminum alloy.

EVALUATION AND TESTING PROCESS

The following example - for evaluation of prestressed building components - might well be regarded as a generally applicable, typical case.

The Soviets have a comprehensive volume of papers on various types of prestressed components which covers such diverse items as (1) prestressed 3 x 12-meter floor slabs for industrial buildings, (2) prestressed trusses supporting flat roof slabs in industrial buildings, (3) similar 30-meter span trusses with continuous prestressed reinforcement, (4) rafters with continuous prestressed reinforcement, (4) rafters with continuous prestressed reinforcement and biaxial transverse compression, (5) prestressed beams with initially prestressed transverse inserts, (6) loss of prestress during accelerated cure of prestressed elements, (7) distribution of stresses along the tops of the ends of girders after transfer of prestress, and (8) performance of precast and prestressed silo ring elements 6 meters in diameter.

Each of these papers represents a study initiated at one of the numerous research laboratories in response to industry's needs for more economical and improved building construction. While the collected works, edited by G. I. Berdichevsky, were published by the Academy of Construction and Architecture of the USSR, the actual experimental work was carried out by various laboratories, including the Central Scientific Research Institute for Concrete and Reinforced Concrete which we visited in Moscow.

Although the analyses of the data and the reports are prepared by the personnel in the research laboratories, the actual testing might be carried out either at the plants producing the experimental elements or at the actual building sites where the elements are subjected to loads as portions of building systems.

The close liaison between the research laboratories which carry out the tests and the industrial establishments where the test specimens are fabricated and tested is also evidenced by the detailed description of the method of fabrication, difficulties encountered in production, and steps taken to overcome the defects and production problems.

Although the authors do not describe clearly the various stages by which the experimental designs and innovations gain acceptance and advance to standards, it is apparent that Gosstroy finally grants its seal of approval after lengthy and exhaustive test programs.

Judging from the above, it is evident that an intimate and continual liaison is maintained between the construction industry (i.e., the precast concrete plants and trusts) and the organizations responsible for carrying out evaluation tests and the development of standards; the latter, in the final analysis, are the various Gosstroys (national and constituent republics). It can be presumed that the USSR is a nation of innovators in which worthwhile ideas, coming either from the production men in industry or the scientists and engineers in research laboratories, are thoroughly evaluated in the generously staffed and equipped research institutes of the nation.

BUILDING STANDARDS

In our discussion at the Central Institute for Concrete and Reinforced Concrete (NIIZhB), we were told by its Director, Professor K. V. Mikhailov, that his Institute has jurisdiction over formulation of norms for standardized reinforced concrete panel buildings. Although Professor Mikhailov did not elaborate on the actual means of arriving at a consensus with other agencies having a substantial interest in such standards, in a subsequent discussion with Mr. Ganichev at Gosstroy we were informed that standards are formulated only after consultation with consumers and producers. It would seem that the Soviets arrive at a consensus much as we do in ASTM and ANSI committees.

It can be safely assumed that the formulation of standards and specifications for various building materials and types of construction is similarly entrusted to the institutes having the proper expertise and competence. The proposed standards are subject to approval by Gosstroy, and once approved they become national standards. Although we were not told of any standards developed on a regional basis, it was emphasized time and again that the national norms are flexible and may be modified to suit local needs and special conditions in the several constituent republics of the USSR.

WRIGHT

REPORT

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BUILDING STANDARDS

The terms "building standards" or "norms" are used in the Soviet Union rather than the term "building codes." In the Soviet system a standard, once adopted, automatically has the force of government behind it and is comparable to a building code in the USA.

Standards are developed under the same vertical structure that exists for research and other functions. At the national level, these are the responsibility of Gosstroy. All standards adopted by Gosstroy are mandatory throughout the Soviet Union. Consideration is given to major geographic zones, e.g., seismic, frigid, etc.; therefore, approval may be obtained for local changes within certain limits. Standards are updated "as necessary."

The degree of flexibility within the Soviet mandatory national code system was not clear. In discussions with

Gosstroy officials, they indicated that new standards and norms were developed by Gosstroy and sent to the republics and the cities to provide additional technical detail. When discussing the same subject in the republics, it appeared that standards were initiated at the local level and adopted at successively higher levels, becoming mandatory at each higher level. When adopted by Gosstroy, these become mandatory for the nation. I suspect the overwhelming trend is from the top down. In some cases, however, standards do evolve from the local level. An example would be the special codes for seismic conditions found in Tashkent.

Gosstroy in Moscow indicated that building changes were relatively easy to make at the local level (with Gosstroy approval). Sometimes a standard could "be revised by telephone" if necessary. The only constraint was technical complexity. However, while visiting DSK-2 in Leningrad, we were advised that it required 14 months to make a change in the standard for an apartment stairway. The technical solutions, including fabrication changes in the factory, required only 5 months of this period.

In the development of new standards, a consensus principle is used. The Institute for Concrete and Reinforced Concrete, for example, develops new building standards for Gosstroy, i.e., they provide the technical input and draft the code. Expert consultants are used, if necessary. The draft is then reviewed by "all who need" the standard; factories, other ministries, republic government, etc. (Such groups are referred to as the consumer.) Before the proposed standard goes to Gosstroy, all negative comments concerning it must be resolved, or the reasons for not resolving them must be presented to Gosstroy.

Gosstroy-approved standards are considered as minimum requirements for construction. However, if a certain industry has special requirements, due to the nature of its work, which are more rigorous than those of Gosstroy, these may be imposed above the minimum standards. In addition to its work on typical designs, Gosstroy reviews the designs for all unique, or special, buildings. A steel building or a bus terminal may be considered unique buildings; one due to design (in which a material other than concrete is used), and the other due to its highly specialized function.

RESEARCH

• Structure of the Building Research Community

Building research in the Soviet Union reflects the same degree of centralization and vertical structuring as do all other major functions. Thus research pertaining to building construction comes under Gosstroy, the State Committee for Construction Affairs for the USSR. Gosstroy has under it, at the Federal level, a number of research institutes, each highly specialized. It is at this level that the most fundamental research is carried out, although applied research is an important function as well.

Within the Gosstroys of the individual republics research institutes exist also, but the level of effort here is much more in applied research, development, and technical service to factories. Laboratory facilities are less elaborate in the republics. Within the construction departments of cities and within factory-building combines, the laboratories are essentially control labs. Each level of the hierarchy depends on the larger, more basic laboratory of the larger governmental unit for support. For example, the Uzbek Republic, where seismic problems are most severe, has its own seismic laboratory. However, the most fundamental research, and the most elaborate facilities for seismic research are in Moscow in the Institute for

Structural Design under the National Gosstroy. Of course, the laboratories coordinate their work.

Laboratory directors at all levels indicated that there is close coordination between the universities and the research institutes under Gosstroy. In the Building Structures Institute in Kiev, we were advised that members of the Institute occupied chairs in universities; also, that a strong tie exists between the Institute and the Soviet Academy of Sciences. The practice of engaging expert "consultants" to contribute to certain types of research projects does exist. The systems appear sufficiently flexible to bring experts together from organizations outside a given Institute to work on specific programs. It was not clear what levels of authority are required, but it was indicated that the use of consultants is a common practice.

Visits were made in Moscow to the Institutes of Concrete and Reinforced Concrete (TZNIISK), Structural Design, and the Central Scientific Research Institute of Experimental Housing Construction. The staffing of these institutes is large, but one must realize that this represents the effort for the entire nation. There is no private industry with its own in-house research activities as is the case in the USA. So Government-sponsored research equals total research in any given field. TZNIISK has a staff of 1,000; 400 are professionals with the equivalent of 15 PhD's and 135 Masters. Its annual budget is 3 million rubles, 75 percent of which comes from Gosstroy and the remainder from combines (factories) requiring their assistance. Program selection is based on recommendations of the Institute staff and on orders from Gosstroy to work on specific problems.

• Research Laboratories

TZNIISK, though engaged in basic engineering research, also carried out applied research, product development and technical service to factory combines. In visiting its laboratories, it was apparent that much full-scale testing was carried out and the laboratories were well-equipped for such work. There was an actual "factory" on the premises for the manufacture of precast concrete components. The Institute also works closely with full-scale industrial factories and thus does much of its research on a field scale, i.e., in actual production. It appears a common practice in the USSR to work with full-scale components, buildings and building complexes, in contrast to the USA where much laboratory simulation and modeling is the practice prior to full-scale field tests.

TZNIISK also has within its structure a Bureau of Realization with a staff of 350 people and a budget of 1 million rubles. Its purpose is to introduce innovations into practice. Funding comes from sources other than Gosstroy research funds. Time did not permit discussions on the successes of this Bureau, but the concept seemed a very logical one and in theory, at least, could be most effective in getting research results put into practice.

In laboratories at all levels, it was apparent that most equipment was "home-made" and not highly sophisticated; particularly in the laboratories of the republics. Notable, too, was a lack of sophisticated electronic data acquisition equipment. Most acquisition and data reduction appeared to be carried out by manual methods.

[Note: The US Delegation on Industrialized Building concentrating primarily on production and construction, spent only a limited amount of time visiting research laboratories. While it was possible to gain much insight into the overall research pattern, time did not allow in-depth technical discussions. Dr. E. O. Pfrang, Chief, Structures Section, Building Research Division, National Bureau of Standards, visited Moscow in May of 1969. He was able to concentrate more fully on laboratories concerned with building research than was the present delegation. To add further to the topic of "Research", a part of Dr. Pfrang's report is appended to this report.]

In conclusion, one must be cautious as to the total building research effort in the USSR. The term "research" is used extensively; the numbers of professional staffs are very large. But many engineers and architects, particularly, are not involved in research at all and have no laboratory facility at their disposal. Their concerns are in planning, standards, production and construction. Then, too, many laboratory activities are in the area of product and technical service rather than research. A realistic comparison with building research in the USA would be most difficult to make.

EXCERPTS FROM TRIP REPORT OF DR. E. O. PFRANG

<u>May 15, 1969</u> <u>Moscow, USSR</u>

On Thursday, May 15, 1969, I visited the Research Institute for Concrete and Reinforced Concrete and the Research Institute for Building Structures. Both of these are institutes within Gosstroy (the State Central Committee for Construction Affairs of the USSR). Initially I met with Dr. K. V. Michailov who is Director of the Research Institute for Concrete and Reinforced Concrete, Gosstroy, USSR, Moscow, Prospekt, Marx, IV, and Dr. Poljakov, Deputy Director of the Central Research Institute of Building Structures, Gosstroy, USSR, Prospekt, Marx, IV.

In addition to these two gentlemen, three division heads of the Research Institute of Concrete and Reinforced Concrete were also present. These were: Professor A. Vasiliev, Manager of the Laboratory for Reinforced Concrete Structures; Professor G. Berdichevskij, Manager of the Laboratory of Prestressed Reinforced Concrete Structures; and Professor N. Kormev, Manager of the Laboratory of Lightweight Reinforced Concrete Structures.

Professor Michailov acted as host at the meeting and was exceedingly friendly. He described to me the variety of research which is carried out within his institute, and then Dr. Poljakov went on to describe the work within his institute. Initially the Research Institute for Building Structures was a part of the Research Institute of Concrete and Reinforced Concrete. The Concrete and Reinforced Concrete group became so large, however, that it was considered advisable to split. The Concrete and Reinforced Concrete Institute now has approximately 1,000 employees. Of these, over 200 are professional personnel. Approximately 300 of this total of 1,000 are assigned to field work introducing into practice that which has been learned in the laboratory. Both institutes, in addition to doing experimental work, do a considerable amount of analytical and design work. The Research Institute for Building Structures has approximately 700 employees. In addition to developing knowledge concerning fundamentals of structural behavior, both institutes are also very much product-oriented.

For example, I witnessed a major activity which was underway in the development of prestressed concrete hydraulic presses. This is the type of work which would clearly be carried out by American industry rather than government. American industry would do this in secret. Here in the Soviet Union, however, a national laboratory was doing an outstanding job of trying to develop a far cheaper way of making hydraulic presses. Apparently these experiments are proving quite successful. Much of the work that I saw going on in the laboratory was directed towards problems related to industrialization of the building process.

Two things which awed me during my visit to the laboratories were; 1) the almost total lack of good housekeeping procedures. The laboratories are dirty, cluttered, and extremely dangerous. Although it was difficult to tell, I also suspect that there was some lack of control by the professional staff over the experiments which were being carried out. 2) The second point which I noted was the lack of sophisticated electronic data acquisition equipment. In most of their static tests they are recording their data manually or, if they are using automatic data acquisition equipment, it has extremely slow speed and they are in turn reducing all of their data by hand rather than using the computer.

The Research Institute for Building Structures had a considerable amount of work underway on structural dyanamics; however, all of this work was being carried on using a sinusoidal load input rather than random load input. Again, in this case, data acquisition equipment was not particularly sophisticated. They were using multi-channel recording oscillographs for this work. Since both institutes are located at the same general location and apparently share a number of facilities, it was rather difficult to determine where the activities of one institute dropped off and those of the other picked up.

I was highly impressed by the extent of some of their laboratory equipment. For example, they have an actual factory on the premises for the manufacture of precast components. This factory is capable of producing precast prestressed beams and trusses of very large size. Their prestressing bed is approximately 150 meters in length.

They also have very advanced machines for the preparation of wall panels and slabs. The Institute has its own central batching plant and is turning out a fantastic amount of work. I doubt that all of the laboratories in the United States combined test one-half the number of specimens that this laboratory tests. On the negative side, however, it was not obvious that they were properly treating their data once they had accumulated it. It appeared to me, from superficial observations, that they were using far too much instrumentation in the form of strain gauges and dial gauges and that they were doing far too little in the way of analysis of the data thus acquired. I also suspect that their professional staff does not have a high degree of control over the laboratory operations.

May 16, 1969

I visited the Central Research Institute of Industrial Buildings. At this meeting I was hosted by the Director of the Institute, Mr. V. Karashov. and its Deputy Director Mr. Kalantarov. The Research Institute for Industrial Buildings is also a part of Gosstroy (State Central Committee for Construction Affairs of the USSR.) This Institute has approximately 1,000 employees. It is devoted to all aspects of building for industrial needs. As a part of USSR for industrial buildings. These standards cover the various types of industrial buildings used in the USSR, and apparently cover all aspects of standardization down to standards related to medical facilities needed as a part of the industrial operation, restrooms, etc., and, of course, the basic things such as structural requirements. In addition to this activity, the Institute is engaged in a major program aimed at the development of typical buildings for industrial use which are mass produced by factory type operations. They have, to date, developed two building systems, one for single-story construction and a second for multistory industrial buildings. Both solutions are in prestressed concrete. This Institute has prepared catalogs of these building systems and all that a designer essentially has to do is select from the catalog. There are some 7,000 factories within the Soviet Union which produce these components. Apparently, considerable pressure is being placed upon industry to require that it use these standard or typical buildings wherever possible. I gathered from our conversations that there is, however, a degree of reluctance on the part of Soviet industry to use these solutions in all cases.

It was rather interesting that in possibly the two largest manufacturing buildings which are now under construction within the Soviet Union, the new Fiat factory on the Volga and the Moskvich factory in Moscow, the industries involved have rejected the use of the typical buildings and have insisted upon steel construction for both buildings. My Russian host pointed out that this decision was based more on matter of emotions than economics. The claim was made that Fiat, being an outside company, was given a little more leeway than usual.

In the earlier Soviet five-year plans, most emphasis was given to the development of basic industries. In the current and future five-year plans, far greater emphasis is being given to lighter industries such as electronics, instruments, consumer goods, and so on. These industries are more interested in the multistory industrial building than in the single-story mill type industrial building. In addition, I gathered that these industries are apparently also causing some stir within Gosstroy by demanding a much higher quality of building than did the basic industries.

It is interesting to note that the building systems which the Russians have developed for industrial buildings are essentially structural systems. Relatively little attention has been paid to the incorporation of any of the service systems within the buildings.

appendix

QUESTION SET

(Prepared by American Delegation of Specialists in the field of industrialization of construction.)

PART ONE

MANAGEMENT

(Relating to Process and concerning the movement, efficiencies of people and things.)

1. USERS NEEDS

   A. Are users ever called in to help plan buildings?

   B. What preference do the users have relating to space arrangements and amenities.

   C. What are the types of, and accessibility of, Community Facilities in residential areas? How long are they open? Are they heavily used?

   D. What effects do the provision of these facilities have on design of dwelling space?

      1. on illumination levels?

      2. on food preparation and storage?

      3. on heating and ventilating?

      4. on space requirements?

   E. Is there a body of what we speak of as "USER NEEDS?" Do they have an impact on design and construction? Is there a feedback mechanism?

2. SYSTEM APPROACH

   A. Are computers used in programming building?

   B. Have performance specifications been developed based on users' needs, i.e., accoustical control, ventilation requirements?

C. What type of scheduling procedures are used in planning construction operations? Are computers used extensively?

3. COST CONTROLS

A. Is cost control a consideration from conceptualization to finished building?

B. How are costs determined?

C. What are your units of measures of cost?

D.

E.

4. CONSTRUCTION PROCESS

A. What is gross output, that is, the number of dwelling units produced by a factory in a year? How many square meters of floor space? What is output expressed in cubic meters of concrete?

B. How many workers in the factory? How many hours worked in a year by each worker? How many are supervisors?

C. Does the factory control the transport to the construction site? How many men, how much equipment involved?

D. What number of workers involved in field assembly? Broken into how many crews? Ratio of supervisors to workers? Average number hours worked in year? What amount of time lost due to weather and other reasons?

E. In field work, what percent of the work is erection? patching? (work to correct poorfit or malfunction) finishing?

F. How many lifts/day from their CRANES? What are the weights of lifts? How are they scheduled?

G. What proportion of housing is built in the different urban areas using industrial methods?

H. Are enclosures used in winter construction? What proportion of projects require sheltering?

I. Who works out erection sequence forecast? Designers or production plant or construction agency?

J. What are safety statistics by category of prefabrication plans, on-site construction, industrial plant?

5. DESIGN/PLANNING PROCESS

A. Is the principal responsibility for regional planning at the Republic level of government? How much control is exercised by the State?

B. How is the location of major industrial installations determined? What about locations of other major public facilities and institutions?

C. What determines the location of new towns? How is the development of a new town administered--from planning to construction to settlement? How are new town residents determined?

D. Is there a deliberate effort to building housing and community facilities so as to encourage interaction between workers, managers, and professionals?

E. How long does it usually take for an innovation to appear on the production line?

F. What are the priorities in building, i.e., schools, housing, hospitals, etc.?

G. What is the organization, design responsibility, construction responsibility, maintenance responsibility, control, and inspection for a large apartment or institutional complex?

H. For large apartment or institutional complex, how long from approval to completed construction?

6. FIRE SAFETY AND CODES

A. What is the "fire load" in dwellings?

B. What are the combustion characteristics of the materials in apartments?

C. What are the characteristics of fires that do occur?

D. What are the occupant's responsibilities for fire prevention?

E. What are the responsibilities of the fire prevention and detection personnel?

F. How are smoke and gas spread prevented?

G. What is the fire loss record (in terms of "buildings at risk")?

H. How many fires per capita? (fires are defined as not occupant extinguishable)

I. What are the building standards for fire exiting, ratings, etc.?

J. Is there research (where, who, etc.) on <u>prediction techniques</u> for buildings* response to fire?

(*structural and fire spread)

K. Are there full-scale tests of whole building systems?

L. Are fire resistance rates determined by test or analytically?

M. Is there a time-temperature curve for fire ratings or are panels of combustibles limited?

N. Are support conditions considered in fire endurance requirements?

O. On codes--who write? who enforce? How often revised?

7. <u>ECONOMICS</u>

A. Do you use standard plans as a means for economy? Examples.

B. Which are more economical--high rise or low rise?

c. What precent of total construction, financing, and operating costs does the rent paid by tenants cover?

8. <u>PRODUCTION/CONSTRUCTION EFFICIENCIES</u>

A. Do you have as a goal, absolute minimum labor at the building site? If so, is progress being made to keep on-site labor to a minimum?

B. For each category of (a) prefabricated wood single-family housing, (b) on-site wood single-family housing, (c) prefabricated apartment-school-institutional building, (d) on-site constructed apartment-school-institutional building.

1. Types of units pre-fabricated (box, post/beam, etc.) and materials used?

2. Degree of prefabrication, i.e., entire, shell, ducts, bathrooms, etc.?

3. Tolerances, i.e., 1 cm per 15 m?

4. Height limitations on stacking?

5. On-site prefabrication practices compared with those in plants?

6. Who is responsible for quality control?

7. Average years of experience of labor?

8. Percent women workers?

9. For a typical plant and construction site, what are production totals (i.e., equivalent floor area produced) and total manhours used (by workers and supervision separately)?

10. Annual square meters of buildings completed?

11. Manhours spent on construction of each category for same year as in item 10?

9. LABOR SKILLS

A. What are the schools or training programs for craftsmen?

B. Do you have jurisdictional problems? Is labor categorized by skill types and do these restrictions deter construction progress?

C. Do trade unions provide training?

D. Are there any opportunities for apartment tenants to save money by working on project before completion?

10. EQUIPMENT AND MACHINES

A. Are machines used to cut down labor or are they used to do things labor cannot do?

B. Is equipment developed to increase production rate or to reduce labor? Example?

11. TRANSPORTATION

A. What are the weight and size limitations on hauling prefabricated material from plant to construction site?

B. What percentage of cost is transportation to total building construction cost?

C. What are principle types of transporting vehicles?

PART TWO

DESIGN

(Relating to PRODUCT and concerning the "what-it-is" and how it performs.)

1. BUILDING SYSTEMS

A. If building systems are classified in terms of "boxes," "big panels," and "pieces and frames," do you have all four represented?

B. Are there tendencies towards the use of "Open Systems," or those which permit a wide variety of components to be utilized?

C. How frequently are there "Model" changes in either a closed or an open system? Are there "local" modifications to systems? What is the impetus to these changes? Are they cost, newly felt user needs, or politically linked issues?

D. How long does it take to make changes in the construction process and the buildings themselves?

E. What is recognized as the most successful building system in the USSR, functionally, economically, and aesthetically.

F. Is the building system concept (large component built at the factory keeping site labor to a minimum) used for schools, hospitals, university and shopping centers?

G. What do architects do and what do engineers do in the development of systems?

H. How successful have you been in integrating the mechanical and electrical subsystems? Is this done at the factory? At the site?

I. Are there any "performance" type prefabricated systems, such as a "specification only" without design and the supplier takes responsibility for design manufacture, installation and maintenance for a long period after construction completed? Systems would be heating and ventilating, plumbing, electrical or a combination.

J. Are there inputs from "soft" science to design process?

2. SPACES AND FORMS

A. How often are floor space standards revised? What are the current standards, i.e., area per adult, area per child, kitchen, bathrooms, etc.

B. Does system building inflict restriction on space such as having the bedroom the same size as the living room.

C. Do you have "mobile homes?" If so, what size unit?

D. What about placement of components on grid lines? face, center line, etc.

E. Vertical module (basic) same as horizontal?

F. Ceiling-floor sandwich is space allocated to electrical-mechanical, etc.

G. Are cabinets made to modular standard?

H. How much function of integration occurs between sub-systems?

PART THREE

TECHNOLOGY

(Relating to Research and Practice and concerning development, fabrication and erection--"how the pieces go together, the how-to-do" so to speak)

1. ACOUSTICS

A. What method do you use to measure impact noise transmission and air borne sound.

B. What provisions are made for sound control? from street to building? from apartment to apartment? from floor to floor? from room to room?

C. Is there a body of noise standards? How have they been derived?

D. What kind of research is being done on the sound transmission characteristics of various building systems?

2. MECHNICAL AND ELECTRICAL

A. What are the characteristics of the systems used for heating, cooling, plumbing (water supply and sewage), ventilating, electricity and lighting, building transport (elevators, escalators), temperature control, fire prevention, trash and garbage disposal. Furnish diagrams and descriptions.

B. What parts of (A) are: a) factory fabricated, b) job fabricated, c) job assembled.

C. What materials are used in these systems.

D. Incorporated in the building, what are the life expectancy as compared to the building structure of these systems?

E. What maintenance methods are used? Are costs high? System reliability?

F. For factory fabricated systems: What means of dimensional and quality control are used? How are systems tested in the factory? At the site?

C. What criteria is used to select the various systems and is there an attempt to integrate these systems with the structure?

3. <u>PRECAST/PRESTRESSED CONCRETE</u>

A. What percentage of precast and prestressed concrete is pretensioned? What percentage is post tensioned?

B. What is seismic philosophy? i.e., ductile frame, shear wall.

C. Are there height limits to tall structures in areas of known seismic activity.

D. What are limits in width of flange for T beams.

E. Is partial prestressing premitted? i.e., a mixture of prestressed and non-prestressed tensile reinforcement.

F. What percent of loss is assigned to relaxation of prestressing steel.

G. Is design by ultimate strengths or elastic analysis? Is redistribution of moment permitted?

H. What is concrete strength used for design? What strength of steel is used? What strength prestressing steel is used?

I. What is tensile stress under dead and live load combined?

4. <u>STRUCTURAL SYSTEMS OTHER THAN CONCRETE</u>

A. What are the proven types of concrete prefabrication compared with newly developed (but unproven) schemes.

B. What are the proven types of wood, metal or plastic prefabrication compared with newly developed (but unproven) schemes.

C. Are prefabricated masonry panels used?

D. What is the maximum allowable height of load bearing masonry structure. By reinforcement? By non-reinforcement?

E. Are plastics being used structurally? Aluminum?

5. UTILITY SERVICES

A. What are the characteristics of the technologies which connect buildings to major utilities? Are there sophisticated hardware systems for road building, utility tunnels, etc.? What has been the experience with large, central generating plants?

B. What level and quality of utilities are provided?

C. What is the configuration of utility runs in buildings, building to apartment?

6. RESEARCH

A. What is the structure, responsibility, and position of the Building Research Community? What is the relationship of RESEARCH to the Building Combines? What are the qualifications, training patterns and procedures of the Personnel?

B. How are priorities established? What are they now? What is the balance of long versus short range considerations? Is there a clearly stated National Policy to which the Building Research Community can respond?

C. What is the present Inventory of Housing and Community Facilities? What are the projections for the future, and how is Research being organized to meet the demand? What are the techniques being used to answer these questions?

7. EVALUATION AND TESTING

A. What are the procedures for the development of tests for:

1. Materials.

2. Building Components.

3. Building systems.

4. Basis of acceptance of new materials, new building systems and innovations.

B. What are the procedures for the development of new materials and building systems, and construction techniques.

C. What organizations participate in the development of innovations?

8. BUILDING STANDARDS

A. What are the procedures for the development and implementation of building standards? National basis? Regional basis?

PERSONS INTERVIEWED

- MOSCOW -

Name	Title & Agency	Date
Krivenko, P.N.	Deputy Chief, Office of Foreign Relations, Gosstroy of USSR	8/23
Sergeyev, E.S.	Chief, Civil Engineering Section, City Council of Moscow	
Buyanov, A.F.	Director, Institute of New Structural Materials	
Meshkov, V.Z.	Junior Scientific Associate, Central Scientific Institute for Concrete and Reinforced Concrete	

Gosstroy

Name	Title & Agency	Date
Ganichev, I.D.	Deputy Chairman of Gosstroy of USSR	8/25
Bakuma, P.F.	Chief, Office of Scientific Research on New Technology, Gosstroy, USSR	
Eremolenko, V.G.	Chief, Department on Foreign Relations Gosstroy, USSR	
Poluchenov, A.F.	Director, Institute for New Structural Materials	
Putyato, N.A.	Senior Engineer, Department of Foreign Relations, Gosstroy, USSR	

Gosgrazhdoanstroy 8/26

(Moscow Housing Construction Committee)

Zmeul, S.G.	First Vice Chairman of the Committee
Bezrukov, E.	Deputy Chief, Office of Personnel and Foreign Relations
Butuzov, V.A.	Chief, Office of Housing Construction
Plotnikov, Yu.A.	Senior Engineer, Office of Personnel and Foreign Relations
Kudryavtzev, ____	Member of the Committee, Department of City Planning

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Tzniepzhilishcha 8/26

(Central Scientific Institute of Experimental Housing)

Rubanenko, B.P.	Director of the Institute
Crippa, A.U.	Deputy Director
Meerson, D.E.	Chief, Office of Typology Department
Khazanov B.D.	Chief, Modular Coordination Department
Stavrosky, ____	Chief, Laboratory for Technology of Prefabricated Housing
Nickolaev, ____	Chief, Department for 3-D Blocks
Shcholnikov, ____	Manager, Scientific and Technical Colaboration Foreign Countries

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Prokatedetal' 8/26

(Rolled Concrete Panel Plant)

Lykhin, G.N.	Director of Plant
Berger, D.I.	Chief, Special Construction, Bureau of Plant

Glavmosstroy 8/26

Galitzky, V.N.	Deputy Chief, Glavmosstroy
Vishnevsky, V.A.	Deputy Chief, Technical Direction
Kazancheyev, A.E.	Assistant to Deputy Chief, Glavmosstroy

Glavmostromstroymaterial 8/27

(Head Office of Moscow Industrial Material)

Dudorov, N.P.	Chief, Industrial Structural Materials and Components Directorate
Ivanov, S.A.	Deputy Chief, Industrial Structural Materials and Components Directorate
Ershov, I.L.	Deputy Chief, Industrial Structural Materials and Components Directorate
Lebedev, S.M.	Chief, Office Foreign Relations

Plant No. 9 8/27

(Precast Concrete Units)

Pinchenko, I.D.	Director of Plant
Mal'tzev, A.	Engineer, Production Department
Shilyaev, G.A.	Chairman, Plant Committee

Wood Working Plant 8/27

Martynov, A.F.	Director of Plant
Shturov, R.F.	Shop Foreman

Permanent Exhibit 8/27

(Building Materials)

Sosulina, T.A.	Senior Metallurgical Engineer
Gol'benberg, V.N.	Chief, Exhibits Department

- LENINGRAD -

Glavleningradstroy 8/28

(Headquarters, Leningrad Construction Department)

Evlampiev, K.A.	Chief, above agency
Alexeyev, A.M.	Deputy Chief, above agency
Evdokimov, V.A.	Manager, Glavleningradstroy Trust
Ber, A.S.	Chief, Office of Economic Planning (above agency)
Belikhova, M.N.	Senior Engineer, Office of Technical Direction (above agency)
Nikolayev, S.A.	Engineer, Glaveleningradstroy Trust

Glavzapstroy 8/28

(Headquarters, Northwest Housing Administration)

Glukhovskoy, K.A.	Chief, Housing Construction Office, Ministry of Construction, USSR
Likhachev, V.E.	Deputy to K.N. Glukhovskoy
Kurochkin, L.I.	Chief, Technical Direction (above agency)
Kheudkov, D.P.	Director, Office for Organizing Mechanical Production

D.S.K. No. 2 8/29

(Housing Building Combine #2)

Krupin, A.D.	In charge of production D.S.K. No. 2
Kasiler, N.E.	Chief Designer for Combine
Fokin, V.P.	Chief, Technical Division

Lenznieep

(Leningrad Central Scientific Institute Economic Planning)

Karachin, A.V.	Director of Institute
Antonov	Chief, Technical Division
Marochnin, L.I.	Chief Design Engineer
Zusser, ____	Chief Specialist
Kurbatov, O.A.	Chief Specialist
Tanoyan, ____	Chief Project Engineer
Belov, B.D.	Chief, Metal Construction Department
Gal'perin, L.Yu.	Laboratory Supervisor
Spunchenko, ____	Chief, Specialist, Planning
Kosaya	Cellular Concrete Engineer
Liber	Chief Specialist

- KIEV -

Gosstroy, Ukrainian SSR 9/1

(Headquarters, Construction Department, Ukraine)

Burka, M.I.	Chairman, Ukr. Gosstroy
Artuknovsky, N.Ya.	Deputy Chairman, Ukr. Gosstroy

Spaunov, B.P.	Deputy Chairman, Ukr. Gosstroy
Kalyubakan, A.V.	Chief, Office for Organization and Economic Planning, Ukr. Gosstroy
Vasyukov, N.T.	Chief, Office of Housing and Public Buildings Construction, Ukr. Gosstroy
Shul'kevich, M.M.	Chief, Office for Research and New Techniques, Ukr. Gosstroy
Abyzov, A.G.	Deputy Chief, Office of Industrial and Hydraulic Structures, Ukr. Gosstroy
Kurkevitch, F.U.	Assistant to Chairman, Ukr. Gosstroy
Shurovskiy, V.S.	Senior Engineer, Foreign Relations, Ukr. Gosstroy
Slipchenko, P.S.	Director, Scientific Research Institute for Automation, Systems Planning and Construction Management
Gordnichev, V.M.	"
Odinetz, V.I.	Chief, Foreign Relations Division of Scientific Research Institute
Pylnick, E.A.	Chief, A.P.U.* (?) Office, Ukr. Gosstroy

Kiev

Glavkievgorstroi 9/1

(Kiev Municipal Housing and Public Construction Department)

Stremoukh, P.S.	Chief, Glavkievgorstroi
Kushnarev, N.I.	First Deputy Chief, Glavkievgorstroi
Rudov, M.V.	Deputy Chief, Glavkievgorstroi
Ziuko, V.I.	Assistant to Chief, Glavkievgorstroi
Kolesnikov, E.P.	Manager, "Kievgorstroi" Trust (of Kiev Construction Organizations Trust)

Mashevskiy, N.V.	Chief, Technical Division of Glavkievgorstroi
Leshchinskiy, M.Yu.	Chief, Central Laboratory of Glavkievgorstroi

D.S.K. No. 3 9/1

(Construction Combine No. 3)

Astashkevich, G.S.	Director, D.S.K. No. 3
Koreniuk, A.G.	Chief Engineer, D.S.K. No. 3

Kiev, Construction and Building

Erecting Trust No. 1, Ministry of

Industrial Construction of Ukrainian SSR

Luzin, Yu.N.	Chief Engineer, Trust No. 1
Gedroitz, M.V.	Deputy Manager of Office of Economic Planning, Trust No. 1
Lobanov, M.I.	Deputy Minister, Ministry of Industrial Construction, Ukr. SSR

Kiev, NIIASS 9/3

(Scientific Research Institute for Automated Systems of Planning and Construction Management, Gosstroy of Ukrainian SSR)

Dr. Slipchenko, P.S.	Director of Institute

Dr. Rybal'skiy, V.I.	Deputy Director of Institute (In charge of scientific work)
Odinetz, V.I.	Manager of Office of Foreign Relations of the Institute

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Kiev - NIISP 9/3

Scientific Research Institute for Construction Industry, Gosstroy of Ukr. SSR

Gorodnichev, V.M.	Director of NIISP
Luik, I.A.	Deputy Director of NIISP
Sobaldyr, V.P.	Manager, Division of Process Technology
Khudenko, A.A.	Manager, Office of Construction Information

- TASHKENT -

Gosstroi of Uzbek SSR

Shakhov, A.T.	Chairman, Gosstroy of Uzbek SSR
Markov, A.G.	Chief, Office for Organization and Mechanization of Construction, Gosstroy of Uzbek SSR
Aliver, G.U.	Director, Zonal Scientific Research Institute for Experimental Design
Israilov, I.V.	Director of Uzbek Republic Design Institute "Uzgosproekt"
Gursunov, F.Yu.	Deputy Manager, Office of Architectural Direction, and Deputy Chief Architect, City of Tashkent
Krapov, A. B.	Chief Engineer, "Tashguiprogor" (Institute for Design of Tashkent City)

Alivayer, A.M.	Senior Architect, "Tashguirprogor"	
Adamov, L.T.	Chief Architect, "Tashguirprogor"	
Asanov, A.A.	Chief Designer, "Tashguirprogor"	
Yakushev, A.V.	Chief Architect, City of Tashkent	
Rushkovsky, O.A.	Director of Institute "Tashguirprogor"	

<u>Glavtashkenstroi</u> 9/5

(Tashkent Municipal Construction Department)

Markin, V.N.	Chief, Glavtashkenstroi	
Umarov, A.U.	First Deputy Chief, Glavtashkenstroi	
Datskovskiy, I.B.	Chief, Technical Division, Glavtashkenstroi	
Buzulutskiy, E.F.	Deputy Chief, Technical Division, Glavtashkenstroi	
Kashinov, A.A.	Chief, Housing Construction Combine	

- MOSCOW -

<u>NIIZhB and NIISK</u> 9/8

(Scientific Research Institutes for Concrete and Reinforced Concrete, and for Structural Components)

Mikhailov, K.V.	Director, NIIZhB Institute	9/8
Mikhailov, V.V.	Manager of Laboratory, NIIZhB	
Aleksandrovskiy, S.V.	Deputy Director, NIIZhB	
Berdichevskiy, G.I.	Manager of Laboratory, NIIZhB	

Khaidukov, T.K.	Manager of Laboratory, NIIZhB
Volkov, Yu.S.	Section, NIIZhB
Polyakov, S.V.	Deputy Director, NIISK (Sc. Res. Inst. for Struct. Components)
Konstantinova, T.V.	Guide assigned by Gosstroy

Moscow - NIISK 9/8

(Note: D. Watstein conferred with two members of Masonry Research Laboratory of NIISK while the rest of US Delegation visited the concrete and reinforced concrete laboratories of NIIZhB.)

Sementsov, S.A.	Chief, Masonry Research
Kameiko, V.A.	Section Chief, Masonry Research Laboratory, NIISK

Final Meeting with Gosstroy 9/8

Ganichev, I.A.	First Deputy Chairman, Gosstroy, USSR
Tokarev, A.M.	Minister of Industrial Construction
Chentimirov, M.G.	Deputy Chairman of Gosstroy, USSR

Soviet Questionnaire - What appears below is the translation of a questionnaire to determine user needs which was distributed by the Russians to people living in the Extreme North.

Leningrad Zonal Scientific-Research
and Design Institute for Standard
and Experimental Design of Public
and Residential Buildings, 1966

Dear Comrade,

Improvement of living conditions in the Kraynyy Sever [Extreme North] regions is one of the most important problems facing us in the next few years. To solve this problem, we have to build many new residential and public buildings which would satisfy the working, living and recreational requirements of the Northern towns and settlements.

The attached questionnaire is designed to reveal those requirements. The information, obtained from the questionnaire, will be used to help architects and engineers to consider more thoroughly the needs of the population and to design dwelling houses, nurseries, kindergartens, schools and other public buildings, and also towns and settlements of the North in a way which would best satisfy the needs of the Northerners concerning their housing and everday services, cultural and instructive activities, sports and peaceful relaxation.

Please write your answers in the spaces provided for this purpose. In the questions, where you have a multiple choice of answers, please underline those which coincide with your opinion.

QUESTIONNAIRE No. 3

1. Your place of residence up North: ______________________
(town, settlement,
____
oblast', republic, kray)

2. Your sex: Male, female

3. Your age: _______ years.

4. Your trade or profession ______________________

5. What are you employed as up North ______________________

6. Your family:

Family members (husband, wife, son, daughter, mother, etc.)	Age (years)	Profession or trace (adults only)	Employed as (adults only)	Do they live with you up North (yes, no)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

7. How long have you lived up North: ______________________

8. If you moved here from another region, what was the purpose:
   a) to live and work up North temporarily for ____ years,
   b) to live and work up North permanently.

9. How much time do you spend every day traveling from your home to work and back (total):
   a) up to 15 minutes,
   b) 15--30 minutes,
   c) 30 minutes--1 hour,
   d) 1--1.5 hour,
   e) 1.5--2 hours,
   f) more than 2 hours.

10. If you use any means of transportation to get to work, indicate what kind:
   a) town or settlement bus,
   b) official bus,
   c) official or personal automobile,
   d) train.

11. How much time, free from work and various household duties, have you got left for relaxation and self-education during a week-day (average):
   a) up to 30 minutes
   b) 30 minutes--1 hour,
   c) 1--1.5 hour,
   d) 1.5--2 hours,
   e) 2--3 hours,
   f) more than 3 hours.

12. How often are you engaged in self-education (evening or correspondence courses, self-study of languages or other branches of science):
   a) every day, except Sundays,
   b) twice to three times a week,
   c) once a week,
   d) twice to three times a week,
   e) once a month or less,
   f) not at all.

13. If you do not engage in self-education, give a reason why:
   a) not enough time,
   b) no desire,
   c) do not find it necessary at my age,
   d) do not have suitable room for studying,
   e) there are no proper facilities (textbooks, consultations, etc.),

14. How often do you participate in social work:
    a) once or twice a week,
    b) once or twice a month,
    c) once every two or three months,
    d) not at all.

15. If you participate in social work, state where:
    a) at the place of work,
    b) at the place of residence.

16. Going to theaters or concerts:

How often would you like to go	How often do you go
a) once a week	f) once a week,
b) once or twice a month	g) once or twice a month
c) once in two or three months,	h) once in two or three months,
d) twice, three times a year or less,	i) twice, three times a year or less,
e) not all.	j) not at all.

17. Going to the movies:

How often would you like to go	How often do you go
a) twice or three times a week,	f) twice or three times a week,
b) once a week,	g) once a week,
c) once or twice a month	h) once or twice a month,
d) once in two or three months,	i) once in two or three months,
e) twice, three times a year or less.	j) twice, three times a year or less.

18. Attending social evenings in the club:

How often would you like to attend	How often do you attend
a) once a week,	f) once a week,
b) once or twice a month,	g) once or twice a month,
c) once in two or three months,	h) once in two or three months,
d) twice, three times a year or less.	i) twice, three times a year or less.
e) not at all.	j) not at all.

19. Activities in amateur talent circles or technical, natural-science and other societies:	
How often would you like to participate	How often do you participate
a) twice a week, b) once a week, c) once every two weeks, d) once a month, e) not at all.	f) twice a week, g) once a week, h) once every two weeks, i) once a month, j) not at all.

20. Sport activities (not counting out-of-town arrangements)	
How often would you like to participate	How often do you participate
a) every day, b) twice or three times a week, c) once a week, d) sometimes (occasionally), e) not at all.	f) every day, g) twice or three times a week, h) once a week, i) sometimes (occasionally), j) not at all.

21. Hobbies (needle-work, painting, sculpture, woodworking and others):	
How often would you like to work on your hobbies	How often do you work on your hobbies
a) every day, b) twice or three times a week, c) once a week, d) not at all.	e) every day, f) twice or three times a week, g) once a week, h) not at all.

22. Going to night clubs and restaurants:	
How often would you like to go	How often do you go
a) twice or three times a week, b) once a week, c) once or twice a month, d) once in two or three months,	g) twice or three times a week, h) once a week, i) once or twice a month, j) once in two or three months,

e) twice, three times a year or less.	k) twice, three times a year or less.
f) not at all.	l) not at all.

23. Receiving guests and visiting friends and relatives:

How often would you like to go visiting or receive guests	How often do you go visiting or receive guests
a) once or twice a week,	g) once or twice a week,
b) once or twice a month,	h) once or twice a month,
c) once in two or three months,	i) once in two or three months,
d) twice or three times a year,	j) twice or three times a year,
e) do not go visiting,	k) do not want to go visiting,
f) do not receive guests.	l) do not want to receive guests.

24. According to your opinion, what facilities would be desirable in a Northern town or settlement for relaxation during an extremely severe weather:
    a) winter gardens for children,
    b) winter gardens for a peaceful relaxation of adults,
    c) warm sport facilities from weather elements,
    d) cold sport facilities protected from weather elements,
    e) playgrounds for children, protected from weather elements, at nurseries and kindergartens,
    f) none of the above facilities are needed.

25. During what months do you consider it possible to go for summer country walks:
    a) May,
    b) June,
    c) July,
    d) August,
    e) September.

26. During what months do you consider it possible to participate in summer sports (soccer, volley-ball, basket-ball, tennis, gorodki [kind of skittles], etc.) out of doors:
    a) May,
    b) June,
    c) July,
    d) August,
    e) September.

27. During what months do you consider it possible to go swimming and relaxing on a beach:
    a) June,
    b) July,
    c) August.

28. During what months do you consider it possible to go skiing, skating or to play hockey:
    a) September,
    b) October,
    c) November,
    d) December,
    f) January,
    g) February,
    h) March,
    i) April,
    j) May.

29. During what months do you consider it possible to relax peacefully near your home or go for a walk in a town or settlement park for adults:
    a) March,
    b) April,
    c) May,
    d) June,
    e) July,
    f) August,
    g) September,
    h) October.

30. According to your opinion, during what months it is possible, as a rule, to take your children out for a walk:
    a) September,
    b) October,
    c) November,
    d) December,
    e) January,
    f) February,
    g) March,
    h) April.

31. Where do you usually take your children out for a walk when the weather permits:
    a) around the house,
    b) the nearest public garden,
    c) a city or settlement park,
    d) other places than above.

32. Where do you usually relax outdoors when time and weather permits:
    a) around the house,
    b) in the nearest public garden,
    c) in a city or settlement park,
    d) on the sport-fields,
    e) walk in the streets.

33. What kind of recreation do you prefer:
    a) with other people (in clubs, amateur circles, sport-fields, etc.)
    b) alone (at home, peaceful relaxation or a walk outdoors, hobbies).

Thank you for your consideration and help.

RAPID CONSTRUCTION OF APARTMENT HOUSES
IN THE UKRAINIAN SSR (translation)

RAPID CONSTRUCTION OF APARTMENT HOUSES IN THE UKRAINIAN USSR

Skorostnoye stroitel'stvozhilykh domov v Ukrainskoy SSR (English version above), Gosstroy UkrSSR; Scientific-Research Institute of the Construction Industry, Kiev, 1969.

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A nine-story apartment house was built during September-November of 1968 at the Bereznyaki massif in Kiev by the House-Building Trust of the Glavkievgorstroy [Glavnoye upravleniye po zhilishchnomu i grazhdanskomu stroitel'stvu Kieevskogo gorispolkoma; Main Administration for Housing and Civil Engineering Construction of the Kiev Gorispolkom]. The large-panel house, of the 1kg-480-25 series, containing 144 apartments and 5080m^2 of living space was built by a rapid construction method.

The building was erected by the following foremost crews of the Construction and Installation Administration No. 3: erection crew under the leadership of G. Donets, Hero of the Socialist Labor, I. Kirilyuk's and S. Lyushchenko's painters crews, P. Purin's carpenters crew, P. Rishchinskiy parquet-layers crew and others.

The construction was carried out according to a rapid work method developed by the Kievorgstroy Glavkievgorstroy Trust and the staff of the House-Building Trust.

The building was completed in record time. Construction of the above-ground part of the building took 45 working days (60 calendar days). Erection of floor structures was done in 18 working days, erection of the roof in 4 days, and finishing work was completed in 23 days. This was four times faster than what is specified by the construction time standards approved by the Gosstroy SSSR, and twice as fast as the construction time achieved by the House-Building Trust in the erection of other houses of the same series.

Rapid methods in erection of five-story houses were also used in 1968 by the Donbass builders. As a result, a large-panel building of 60 apartments (above-ground part) was built in 64 days, 58-apartment house in 54 days, 45-apartment house in 50 days and 120-apartment house in 45 working days.

It is intended to broaden the use of rapid methods in the Republic's housing construction in 1969. This year, the Mintyazhstroy UkrSSR [Ministerstvo stroitel'stva predpriyatiy tyazheloy industrii; Ministry of Construction of Heavy Industry Establishments] plans to build six houses by using rapid construction methods, Minpromstroy UkrSSR [Expansion unknown] plans to build 12 houses, Minsel'stroy UkrSSR [Expansion unknown] 10 houses and Glavkievgorstroy 7 houses.

It has been planned to broaden significantly the application of continuous methods in the construction of residential blocks and to change-over house-building concerns and housing construction trusts to continuous production work.

In 1969, the total housing construction by production methods should be 70% in Mintyazhstroy UkrSSR, 55% in Glovkiyerstroy, 32% in Minpromstroy UkrSSR and 10% in Minsel'stroy UkrSSR.

Rapid building method, practically tested in the construction of apartment house No. 18 at the Bereznyaki massif in Kiev, has been approved by the decrees of TsK KP [Tsentral'nyy Komitet Kommunisticheskoy Partii; Central Committee of the Communist Party of the Ukraine [and the Kiev City Committee of the Communist Party of the Ukraine, and it was recommended for wide propagation and adoption in all building organizations of the republic.

RAPID CONSTRUCTION OF A LARGE-PANEL APARTMENT HOUSE IN KIEV

A house of the lkg-480-25 series was built in Kiev. Standard design of the house was developed by the Kiev ZNIIEP [Expansion unknown] of the Gosstroy SSSR.

The house consists of four sections, including 1-2-3-3 row sections and 2-3-3-4 end sections. Structural design of the house is following: two spans of 4.84m with three longitudinal bearing walls and a single, longitudinal 3.2m step of axes. Its height from floor to floor is 2.7m.

Technical and economical characteristics of the house.

Living area	$5{,}080.0m^2$
Useful area	$7{,}222.1m^2$
Site area	$1{,}051.8m^2$
Total volume	$26{,}436.5m^3$
This includes:	
above-ground part	$26{,}181.5m^3$
underground part	$255.4m^3$
Number of apartments	144
This includes:	
one-room apartments	18
two-room apartments	36
three-room apartments	72
four-room apartments	18
Estimated cost	607,000 rubles

The outer walls of the house consist of one layer of claydite-concrete panels, 35 and 40 cm thick, made in 20 standard sizes. The panels are provided with precast window and door (balcony) openings. Outer surfaces of the panels are faced with ceramic tile. The inner walls consist of hollow reinforced concrete panels, made in six standard sizes.

The floors consist of cross-ribbed reinforced-concrete panels, made is six standard sizes of rooms. Partitions are made of rolled gypsum-concrete panels of a room size. Three-layered roofing material comes in a roll, with an internal water drain. Claydite-concrete is used for thermal insulation.

Floors in rooms are made of parquet board, in kitchens and entrance halls they are vinyl tile and in bathrooms, ceramic tile on reinforced concrete.

The house is furnished with a water supply, sewer system, heating, hot water, gas for kitchen stoves, telephones, radio, master TV-antennas, elevators and central trash ducts.

The house was divided, within each floor, into four crane-grab sections for the purpose of rapid erection. The erection was done in two parallel production lines by two half-crews, each of which worked on two crane-grab sections (half of the house) and used one tower crane. To eliminate the transportation of identical parts and structures for each production line during the same day, one half-crew always started working on a floor a day later than the other one.

Erection of each floor took two days, i.e., one day, three shifts each, per one crane-grab section. Other structures of the house were erected in 18 working days, and roof and its covering was completed in four days. Total erection time of the above-ground part was 22 days as compared with an estimated time of 23 days (Table 1).

The following technique of work progress at each crane-grab section was adopted. First and second shifts of each erection day installed the panels of outer and inner walls at two adjacent crane-grab sections, welded anchoring parts in place and filled the joints of inner walls. Simultaneous erection of wall panels at two crane-grab sections was adopted to increase the work frontage and avoid the possibility of erectors standing idle in case of untimely delivery of certain panels. During the third shift of the first erection day and during three shifts of the second day the following operations were performed: installation of partition panels and concrete floors in bathrooms, laying the base for floors, erection of floor panels, stairways, balconies and trash-ducts, welding of anchoring parts, sealing of wall and floor joints and caulking of partitions.

While an upper floor was being erected, the following work was being done at a floor below (one floor between): plumbing and electrical wiring, carpenter's work, plastering, installation of door frames and finishing of woodwork.

Table 1. Distribution of operations for rapid erection of the above-ground part of house No. 18 at the Bereznyaki massif.

Operation No.	Work description	Amount of work: Unit	Amount of work: Number	Crew No.	Team No.	Number of working in a team
1	Erection of outer and inner wall panels lifted directly from trailers	pieces	1278			
2	Electric welding of reinforcing bars, anchoring parts and cutting of loops	lin. m	1440	I--A I--B	1,2,3 1,2,3	10 10
3	Fastening of inner wall joints	lin. m	6948			
4	Installation of partitions and bathroom concrete floors	pieces	828			
5	Laying of under-floors	m^3	349			
	Installation of steam insulation on the first floor	m^2	6973			
6	Erection of floor panels	pieces	504			
7	Erection of stairways, trash ducts and balconies	pieces	297	I--A I--B	1,2,3 1,2,3	10 10
8	Electric welding of anchoring parts for floors, stairs and balconies	lin. m	540			
9	Sealing of outer wall joints and filling of floor joints	lin. m	6480			
10	Caulking of partitions	lin. m	8910			
11	Electrical wiring	man-day	449	II	1,2	8

Table 1. (Continued)

Operation No.	Work description	Amount of work		Crew No.	Team No.	Number of workers in a team
		Unit	Number			
12	Plumbing	man-day	473	III-A	1	8
13	Installation of woodwork and dry-wall partitions	100 lin.m	130	IV-A IV-B	1 1	4 4
14	Plastering, including sealing of holes and grooves	10 m^2	2403	V--A V--B	1 1	8 8
15	Installation of doors, transoms and finishing of woodwork	man-day	144	IV-A IV-B	2 2	4 4
16	Installation of parapets and ventilation blocks	pieces	112			
17	Erection of superstructures for elevator machinery	pieces	24			
18	Laying of bricks in the bearing places of floor panels	m^3	7.5	I-A I-B	1,2 1,2	8 8
19	Cementing of joints between parapet blocks	pieces	76			
20	Installation of steam- and heat- insulation in elevator superstructures	m^2	72			
21	Laying of heat-insulation panels	m^2	1226			
22	Installation of steam-insulation and compensating layer	m^2	1226	I-A	1	8

Table 1. (Continued)

Operation No.	Work description	Amount of work		Crew No.	Team No.	Number of workers in a team
		Unit	Number			
23	Erection of floor panels	pieces	60	1-B	1	8
24	Sealing of joints between floor panels and installation of compensating layer	m^2	1150	I-A	1,2	2
25	Electric welding at erection	lin.m	64	I-B	1,2	2
26	Sheet-metal work on the roof	lin.m	302	VI-A VI-B	1 1	3 3
27	Installation of Ruberoid roof-sheeting	m^2	1299	VI-A	2	12
28	Covering of roof with gravel	m^2	1184	VI-B	2	12

Plumbing and electrical wiring work was done during the first shift starting on the fourth working day, carpenters' work starting on the sixth day, plastering and laying of floors in bathrooms on the eight day.

Finishing work was done after the erection was completed and after the roof was finished (Table 2).

For finishing work, the house was divided into sections in the same manner as for erection. The work was done simultaneously in all four sections of a floor and progressed from the ninth floor down. Finishing work was completed in 21 days, working one shift a day. The total construction time of the above-ground part of the building was 45 working days or 60 calendar days.

Table 2. Distribution of operations for rapid finishing work in house No. 18 at the Bereznyaki massif.

Operation No.	Work description	Amount of work: Unit	Amount of work: Number	Crew No.	Team No.	Number of workers in a team
30	Surface finishing of gypsum partitions	m^3	1391	I	7,8 9,10	10
31	Casting of concrete floors on balconies and in superstructures for elevator machinery	m^3	1209	I,II III,IV	12	2
32	Glazing of windows and doors to the balconies	m^3	1972	I,II III,IV	13	4
33	Installation of built-in closets and entresols	section	4	I,II III,IV	14	6
34	Paneling of balcony partitions and bay windows with asbestos-concrete sheets	m^2	1263			
35	Laying of ceramic and vinyl tile floors. Facing of entrances and trash ducts with glazed tile	m^2	2295	I,II III,IV	15	6
36	Preparation of wall and ceiling surfaces for whitewashing and painting, finishing of drywall	m^2	11215			
37	Priming of wall panels, woodwork, metal structures, plumbing fixtures, closets and entresols	m^2	10339	II	7,8 9,10	65
38	Installation of plumbing fixtures, starting and adjusting the systems	man-day	144	I,II III,IV	16	4

Table 2. (Continued)

Operation No.	Work description	Amount		Crew No.	Team No.	Number of workers in a team
		Unit	Number			
39	Installation of electrical fixtures	man-day	216	I,II III,IV	17	6
40	Laying of parquet-board floors and finishing of their surfaces	man-day	4530	I,II III,IV	18	20
41	Painting of inner surfaces with an improved color paint and whitewashing of superstructures for elevator machinery	man-day	14525	III	7,8 9,10	15
42	papering of walls	man-day	13812			
43	Painting of facade parts with vinyl paint from a bosun's chair	man-day	3310	I,II III,IV	11	3
44	Painting of walls, woodwork, closets, entresols, plumbing fixtures and piping with oil paint	man-day	11607	IV	7,8 9,10	15
45	Installation of handrails on stairs and balconies	lin. m	433	I,II III,IV	14	6
46	Installation of locking devices and weather-stripping on doors and windows	pieces	1551			

The building site for the house constructed by rapid method was provided with approach roads, parking lots for semi-trailers (panel carriers), areas for storing of structures and materials, crane tracks, two tower cranes (erected and tested), temporary facilities for everyday convenience of workers, offices of foreman and work superintendents, and fences around danger zones and the construction site.

Temporary roads, 3.5m wide, were made of prefabricated reinforced-concrete slabs, designed to carry heavy panel-carriers with a total weingt of up to 25 tons. Parking lots for transportation means were located in the vicinity of every crane and provided enough space for simultaneous parking of four semi-trailers or trucks.

The building was erected with the aid of two S-419 tower cranes of 20m boom-out and 3-5 ton lifting capacity. Each crane serviced two crane-grab sections or half of the house. To ensure safe, simultaneous operation of both cranes their action zones were separated by movable rail stops, set at a distance of 31.4m from each other which made it impossible for the booms of two cranes to come closer than 6m to one another. The following order of crane work was observed during erection of the house structures: crane No. 1 works at the first section (crane-grab), at the same time crane No. 2 works at the third section (crane-grab); crane No. 1 works at the second section (crane-grab) while crane No. 2 works at the fourth section.

Erection of outer and inner walls was done by lifting the panels directly from the panel-carriers.

Two truck tractors mark MAZ-504 were used to transport structural items to the construction site. Each tractor pulled three semitrailers mark NAMI-790 and one semitrailer mark MAZ-5242. By having each tractor pull three semitrailers it was possible to use a shuttle method in the transportation of structural items.

The number and capacity of storage areas was calculated to hold the reserve of structures and materials for two floors of the house. An area was also provided for assembling the items of elevator shafts into large subassemblies. Two areas were provided with racks for storage of reserve outer and inner wall panels. In order that such number of storage areas can be placed in the zone of each tower crane, the crane tracks had to be extended 21 m beyond each end of the house.

For sanitary and everyday needs the following temporary structures were built: two accommodation barracks for erectors, two for plumbers, one for electricians, seven for finishing workers, three for offices of foremen and work superintendents, a shower-bath and a toilet.

Electricity, water, steam and gas were provided from permanent city lines. Mortar and concrete was supplied by a central mortar-concrete yard.

To prevent loss of time due to power failure in city power lines, the construction site was provided with a mobile electric power station. In addition to a ready-mixed mortar brought to the site, some mortar was prepared on the spot in a small mortar mixer. Crane parts which most frequently break down were also kept in stock.

Very thorough preparations, which would ensure a successful achievement of rapid construction, were made before erection of the house was started. A plan of work progress for the rapid construction of the house was worked out. An order was issued to the House-Building Trust in which tasks of all the sections participating in the project were defined.

At the job site, all the work on the underground part of the house and engineering structures of the site was completed by the general contractor and accepted. Center lines of the building were plotted by surveyors and screeds for wall panels were provided.

The job site was prepared in accordance with the master plan, cranes were erected and tested and all necessary equipment and tools were brought to the site. Cross-ribbed floor panels, partition panels and floor material, stair stringers and platforms, anchoring parts, reinforcing rods, etc., were stocked in the amount required for two floors of the house. The job site was decorated with posters, slogans and other means of visual propaganda.

Particular attention was given to the organization of efficient and timely supply of products and materials to the site and their delivery in full conformity with transportation-erection charts and supply records. Control over the delivery of products and materials was given to the chief dispatcher of the Trust.

To ensure reliable communications with the control room of the residential area of the Berexnyaki massif, two radio stations of the ARS and "Altoy" type were installed. The dispatcher of the massif had a two-way radio communication with the central control room of the Trust. This made it possible to record all troubles and to take proper measures for their prevention and elimination, and also to control the departure and arrival of all transportation means.

The crews were made up and they were given instructions regarding the work techniques required in the rapid construction. Work-progress schedules, showing the amount of work required for each operation and their completion dates, were brought to every crew.

Erection of the house was given to the SMU-3 erection crew with G.I. Donets, Hero of the Socialist Labor, as their foreman. The crew consisted of:

Foreman VI class.	1 man
Erectors IV class	6 men
Erectors III class.	16 men
Riggers III class	6 men
Mason-concrete workers IV class .	2 men
Mason-concrete workers III class.	4 men
Metal workers V class	2 men
Arc welders V class	4 men
Facade workers V class.	2 men
Facade workers IV class	4 men
Carpenters IV class	2 men
Tower crane operators IV class. .	6 men

Work integrated with the erection was done by five other crews, which included 18-men crew of carpenters, 8-men crew of tile layers, 16-man crew of plasters, 8-men crew of plumbers (SMU-6 of the Kievspetsstroy [Expansion unknown] Trust) and 4-men crew of electricians (SMU-2 of the Kievelektromontazh [Expansion unknown] Trust).

Finishing work was done by six crews: four of painters and two of parquet-layers.

The high level of organizational and technical preparation and adoption of the advanced working technique provided for the successful completion of the house, by rapid construction method, according exactly to schedules provided by the work-progress plan.

Construction of the house was started on 5 September and on 5 November 1968 the house was put into service with a rating of "good".

As a result of the rapid construction of this house, very high technical and economical rates were achieved. These rates are significantly higher than average rates achieved by the House-Building Trust in 1968 in the erection of other houses of the same series (Table 3). Significant reduction of construction time, decreased work input, increased labor efficiency, improved utilization of mechanization means and reduced labor costs should be noted.

High rates, achieved in the rapid construction of the house, indicate that there are great reserves for the reduction of construction and erection time, and the decrease of work input and reduction of net cost of a large-panel house-building.

However, in the construction of the large-panel apartment house in Kiev there were also the following significant drawbacks.

In the design of the house, there are labor-consuming, non-industrial structures which do not correspond with the requirements of rapid construction.

Lack of reserve manufacturing facilities at the DST resulted frequently in untimely completion of prefabricated structures and articles. These items had to be delivered to the rapid construction site at the expense of other building projects.

Use of obsolete tower cranes mark S-419 did not correspond with the requirements of rapid erection.

Problems of artificial drying, essential under the conditions of rapid work progress, were not solved in the plans of work progress or during the preparations for construction.

Adjacent subcontracting divisions of the Glavkievgorstroy (Auto-transport Trust, Stroymekhanizatsya Trust, Kievspetsstroy Trust and others) were not sufficiently prepared to run the job properly under the conditions of rapid construction.

The dispatching administration of rapid construction was carried out without using the modern systems of automated dispatching administration.

Table 3. Basic technical and economic features of the rapid construction of apartment house No. 18 at the Bereznyaki massif.

Feature	Unit	House No. 18	Other houses of the lkg-480-25 series built by DST in 1968
Construction time of the above-ground part of the house.	calendar days	60	140
The above includes erection of the above-ground part of the house. .	working days	22	75
Labor spent per lm of living area total	man-day	1,70	2,24
The above includes: work performed by the DST labor force.	man-day	1,22	1,69
erection of the above-ground part of the house.	man-day	0,39	0,49
work performed by the labor force of subcontracting organizations.	man-day	0,48	0,55
Average fulfillment of production quotas.	%	180-195	150-155
Cost of lm of living area in the above-ground part of the house. .	rubles	101,42	104,92
Savings in the actual construction cost as compared with the estimated cost.	%	8,0	4,5
Average daily output of one tower crane	$1m^2$ of living area	74,85	36,32
Yearly output of one tower crane.	same	27320	13257

RAPID CONSTRUCTION OF APARTMENT HOUSES IN DONETSKAYA OBLAST'

Building organizations of the Donetskzhilstroy Mityazhstroy UkrSSR [Expansion unknown] Concern gained, during the recent years, a considerable experience in the erection of apartment houses by the rapid methods. The best results were obtained by the DSK-1 builders in the rapid construction of house No. 6 in 956 block and house No. 4 in 399 block and by the Donetskzhilstroy No. 1 Trust in the erection of house No. 4 in 32 block in Donetsk, and also by the Makeevstroy Trust in the construction of house No. 12/12a 762 block in Makeevka.

Other apartment houses, of various sizes and structural characteristics, were built in Donetskaya oblast' by the rapid construction methods. Large-panel or brick five-story apartment houses of three, four or six sections were constructed by this method (Table 4).

The rapid construction of apartment houses was preceded by a series of organizational and engineering measures which ensured a successful completion of the construction. The most essential of them were: the development of plans for the rapid production-line methods of house construction; issuing of orders to the Trust, DSK and SU concerning the organization of rapid construction, in which the tasks of all the sections participating in the rapid construction were defined; organization of the delivery of articles, materials and semi-finished products; organization of dispatching communications; manning of the crews participating in the rapid construction; acquainting the engineers, technicians and other workers with the planned rapid construction technology of the house; informing each crew about the volume and completion dates, and issuing of the necessary orders.

According to the plan of rapid construction, developed by the Donorgtekhstroy, erection of a house is done in two periods: Preparatory and main.

During the preparatory period the following work is done: planning of the site; laying of underground pipes and cables; construction of roads and approaches; erection of temporary buildings and structures; construction of storage areas, temporary power lines and roads, workers' accommodations, offices for the engineers and technicians of the general-construction and specialized organizations, methods room and others.

During the main construction period the building is erected and public utilities are installed on the site.

Table 4. Brief characteristics of houses erected by rapid construction methods in Donetskaya oblast

Characteristics description	Unit	house No. 6 in block 956	house No. 4 in block 399	Donetskzhilstroy-1 Trust, house No. 4 in block 32	Makeevzhil-stroy, house No. 12/12a in block 762
Series and types of houses	--	1-480AV	1-464A-17V	1-480-19-A	1-464V-fR10
Number of floors	--	5	5	5	5
Number of sections	--	4	4	3	6
Living area	m^2	1,839	1,851	1,402	3,800
Total volume of the structure	m^3	92,025	110,125	7,331	19,000
Number of apartments	--	58	60	45	120
Structural design:					
foundations	--	Blocks and reinforced concrete			
walls	--	Panels		Bricks	Panels
floors	--	cross-ribbed panels	Flat panels	cross-ribbed panels	Flat panels
partitions	--	gypsum panels	Reinforced concrete panels	Gypsum panels	Reinforced concrete panels

Table 4. (Continued)

Characteristics description	Unit	Donets DSK-1 house No. 6 in block 956	Donets DSK-1 house No. 4 in block 399	Donetskhilstroy-1 Trust, house No.4 in block 32	Makeevxhil-stroy, house No. 12/12a in block 762
Structural design:(Cont'd)					
roof structure	--	Integrated		Sloping rafters	Integrated
roofing material	--	Roll		Slate	Roll
inside finish	--	Wall paper and oil paint		Color and oil paint	

The general process of the house construction is divided into three engineering stages: I -- erection of the underground part of the building; II -- erection of the above-ground part of the building; III -- finishing work. Plumbing and electrical work is included in every stage, according to its type.

During the erection of the large-panel, 58-apartment house No. 6 in 956 block in Donetsk, the following questions were performed:

I stage of work

1. planning of building site; 2. surveying; 3. mechanical excavating and grading of the ground; 4. manual finishing of the bottom of the excavated pit; 5. construction of foundations, erection of walls and installation of horizontal insulation; 6. installation of monolithic girdle and erection of floor panels and stair platforms; 7. installation of vertical waterproofing; 8. filling of spaces between the walls and excavated pit.

II stage of work

9. erection of superstructures; 10. installation of roofing; 11. installlation of electric wiring; 12. installation of telephone and other low-current wiring; 13. installation of woodwork; 14. testing of electric wiring; 15. testing of telephone and other wiring; 16. installation of entrance doors and wooden floors on the first floor; 17. glazing work; 18. plumbing work; 19. interior plastering; 20. testing of plumbing (piping) system; 21. plastering of the ground floor and finishing of stairways.

III stage of work

22. laying of tile floors in the service areas; 23. same in stairways; 24. preparation of surfaces for painting; 25. painting of walls and ceilings; 26. finishing work in stairways; 27. installation of plumbing fixtures; 28. installation of electric fixtures; 29. installation of low-current fixtures (telephones, radios and others); 30. installation of finished floors; 31. acceptance of the installed plumbing and electrical fixtures.

To combine the construction and erection operations, the house was divided into crane-grab sections. In the underground part of the house, one section covered half of the house. In the above-ground part of the large-panel house, one section covered one floor, while in a brick house one floor consisted of 1.5 sections. For the finishing work, each floor of the house was considered as a section.

Particular attention was given to the accurate and timely supply of products which were delivered according to orders and on days specified in the rapid construction charts.

Materials and products for the house built by the Donetsk DSK-1 were supplied by the Administration of Building Supplies (UNR No. 5) of this concern.

The Administration's shops prepared the mastic for cementing the roofing material and vinyl tiles, cut the wall-paper and prepared small gypsum articles. The majority of products and materials were delivered in containers.

Prefabricated structures were being delivered to the job site on NAMI-790 panel-carriers, pulled by a MAZ-200V truck tractor. Other articles were delivered by ZIL-584 in accordance with the transportation and erection schedules. Control over the timely and complete delivery of products and materials to the rapid construction sites was given to the chief dispatcher of the House-Building Concern. The control room of the Donetsk House-Building Concern is equipped with the TsRS radio station. To ensure uninterrupted and reliable communications with the chief dispatcher, supply administration and the DSK services, every job site was provided with an ARS radio station and a telephone.

The work in all engineering stages was performed by the complex crews which consisted of specialized teams. This was done after considering the operations, conditions of a maximum utilization of the work frontage and for the purpose of achieving the highest workers' efficiency.

Prefabricated structures of the above-ground part of house No. 6 in 956 block in Donetsk were erected by the complex crew consisting of 30 men, with V. Chirva as their foreman. The crew consisted of four teams: three teams of erectors and one for finishing the joints of prefabricated structures. This crew erected all prefabricated structures, finished their joints, erected the roof and installed the roofing. All work except finishing of the joints, was being done in three shifts. Finishing of joints was done during the first shift.

The erection time per each crane-grab section was 24 hours. During the first shift, wall panels were installed, anchoring parts were erected and floor anchoring parts were welded. Erection of prefabricated structures was done with a KB-100 crane.

Total erection time for this house was 27 days, including seven days for erection of the roof and installation of roofing.

Electrical wiring, low-current wiring and woodwork was being installed, at the sections where erection was already completed, parallel to the erection operations (lagging two sections behind). Plumbing was started on the seventh day after completion of erection of the second floor, while plastering started on the ninth day.

All the after-erection and finishing operations took as much time as the erection -- 27 days. Finishing work was done "from the top down", simultaneously in all four sections of the house. Instllation of concrete topped floors and tile floors coincided with installation of the roofing, while wall-papering, painting, and installation of other floors was done after roofing was installed.

Erection time of the above-ground part of the house was 54 working days; the total construction time of the house was 70 working days.

Similar to the above was the rapid construction of house No. 4 in 399 block in Donetsk. Erection of the structures and installation of the roof and roof covering was completed in 26 working days. Erection of this house was done by the complex crew of V. Polyarush with the aid of a KB-160 tower crane.

During the rapid construction of brick house No. 4 in the 32 block in Donetsk, which was carried out according to a grid chart, erection work and delivery of materials to the working area was done with the aid of a KB-100 tower crane. Laying of bricks and erection of prefabricated structures was done by a crew of Comrade Bagachev. The work was organized into three shifts. Basically, the materials and structures were fed from the site storage area, with the exception of toilet cabinets and cross-ribbed floor panels which were erected by lifting them directly from the trailers.

During the first shift, materials and structures were being unloaded onto the site storage area by a five-ton mobile crane. Laying of brick walls and erection of floor panels, stair stringers and platforms was done according to the schedule -- four days per floor. The shell of the house was erected in 20 days. After-erection operations were started after laying of the third floor was completed. Plumbing and electrical wiring work was started simultaneously on the 14th day after the erection of the above-ground part of the house. Plasterers started their work on the 17th day and right after them, on the 20th day, joiners and carpenters started (hanging of the doors, installation of door and window frames). At the same time, glazing and installation of slate roofing was being done. On the 23rd day parquet-layers started their work and three days later -- the painters.

Preparation of the surfaces for painting was done according to the schedule -- 15 days per section consisting of five floors, painting -- 5 days per section.

Finishing work was done in three parallel production lines in each section of the house "from the top down". On the 27th day after dismantling of the crane, facing of the facade with tile was started. The facing work was done from a tubular metal scaffolding.

All the work on the facing of outer walls was done in three days. Utilities were being installed simultaneously with the finishing work, after the completion of the building facing and dismantling of scaffolding.

The above-ground part of the house was constructed in 50 working days. The house was accepted by the Government Commission with a rating of "good".

The rapid construction of the above-ground part of the six-sectional, large-panel, 120-apartment house No. 12/12a in 762 block in Makeevka was done with the aid of two tower cranes. Each crane lifted the structures to be erected at three crane-grab sections. Erection of prefabricated structures, with the aid of crane No. 1, was done by the crew of F. Shilov from the Building Administration No. 4 of the Makeevzhilstroy Trust. The crew of S. Piven', from the Building Administration No. 2 of the same Trust, worked with crane No. 2. Sections 1 --3 were serviced by the BK-10 crane, while sections 4--6 were serviced by the BKSM-5-5A crane. To ensure the work safety during simultaneous operation of two cranes, the zones of their action were separated by portable stops set on the crane tracks. During the work of the BK-100 crane at the first crane-grab section the BKSM-5-54 crane worked at the third section. Then the BK-100 crane was moved to the second section and the BKSM-5-5A crane to the fourth section and so on. Erection time of one crane-grab section was four shifts.

The following operations were performed during the erection of this house.

I stage of work

1. mechanical excavation and grading of the ground; 2. construction of foundations and reinforced concrete girdle; 3. erection of floors; 4. vertical waterproofing of walls; 5. filling of spaces between the foundations and excavation pit.

II stage of work

6. erection of superstructures; 7. plumbing work; 8. installation of electrical wiring; 9. installation of door frames, closets and window sills; 10. plastering; 11. laying of ceramic-tile floors in bathrooms; 12. installation of woodwork; 13. testing of plumbing systems; 14. inspection of electrical and low-current wiring; 15. installation of the entrance and vestibule doors; 16. plastering of the ground floor; 17. glazing of doors and transoms; 18. erection of floor panels; 19. installation of slag filling; 20. installation of concrete floor topping; 21. carpeting.

III stage of work

22. laying of parquet floors; 23. preparation of surfaces for painting; 24. installation of plumbing fixtures; 25. painting; 26. installation of electrical fixtures; 27. installation of linoleum floors.

During the first shift of the first day of work on a section and during half of the second shift, outer wall panels were erected. During the remaining part of the second shift and during the whole third shift, inner wall panels, electrical boxes, ventilation blocks and toilet cabinets were installed. During the fourth shift rolled-gypsum base for floors, stair stringers and platforms, floor panels and balcony slabs were installed. Tack-welding of protective grating, anticorrosion protection of welded joints and filling of joints were done during the first day shift, simultaneously with erection of structures.

Both erection crews worked four days on every floor and 23 days on the whole house, including three days for the erection of the roof structures.

Two days after the start of erection, plumbers, electricians and carpenters started working. Plastering work was started on the seventh day, and on the 11th, carpenter's work, pouring of concrete floors and laying of ceramic tile floors.

The laying of parquet floor and the painting started after the whole house was completely erected. Painting was done simultaneously in all section proceeding up from the bottom floors.

All interior doors and built-in furniture were made of wood shavings boards faced with textural paper which decreased the amount of paint required.

The work-progress diagram of three sections of the house is shown in Fig. 8. The above-ground part of the building was constructed in 45 days. The whole house was built in 58 days and accepted by the Government Commission with a rating of "good". As a result of the gained experience in the rapid construction in Donetskaya oblast' the sources of the reduction in construction in Donetskaya oblast' the sources of the reduction in construction time, lowering of labor expenditure and net cost of construction became apparent (Table 5.).

During the rapid construction of apartment houses in Donetskaya oblast' the following difficulties emerged.

The prefabricated structures, parts and articles of large-panel houses were of poor factory finish, panel surfaces required plastering in some places, many door and window units were not painted or glazed, in some of them there were no window sills, etc.

Some of the plants lacked sufficient storage space for storing the required quantity of prefabricated structures and other products, causing interruptions in the rapid completion of some operations.

Supply of prefabricated structures and other articles was not organized accurately, which caused interruptions in providing the rapid construction with the necessary items.

Table 5. Technical and economic characteristics of rapid construction of apartment houses built in Donetskaya oblast

Item	Unit	Donetsk DSK-1		Donetskzhilstroy-1 Trust, house No.4 in block 32	Makeevzhilstroy, house No.12/12a in block 762
		house No.6 in block 956	house No.4 in block 399		
Construction time	days	70	90	91	58
The above includes:					
underground part	days	16	26	41	13
above-ground part	days	54	64	50	45
Labor spent per 1m of living area	man-day	2.36	2.17	2.42	1.97
The above includes:					
erection of underground part of house	man-day	0.14	0.17	0.17	0.13
erection of above-ground part of house	man-day	0.35	0.3	0.45	0.3
finishing work	man-day	1.87	1.7	1.8	1.54
Average fulfillment of production quotas	%	155	155	145	180
Cost of 1m of living area:					
estimated	rubles	113.26	107.94	102.0	100.0
planned	rubles	109.1	104.26	100.0	93.1
actual	rubles	105.8	103.88	98.0	90.1
Savings in actual construction cost as compared with estimated cost	%	7.0	4.0	10.0	4.0
Yearly output of one tower crane	$1m^2$ of living area	17,600	24,200	18,300	15,422

Summarizing the described experience in the rapid construction of apartment houses, the following conclusions can be drawn.

1. The term "rapid construction" can be applied only to the production line construction, in which the ultimately possible combination of simultaneously concurrently performed operations is achieved, the operations are mechanized to the maximum and largest possible number of workers is distributed on the site which results in a high technical and economical efficiency. Thus, in the rapid erection of four-section houses the erection work was done in two parallel production lines (two tower cranes), and finishing work was carried out in four parallel production lines (four crews) simultaneously in all four sections of the building.

2. For successful execution of the rapid construction, a thorough preparation is necessary, which includes the following:

development of the plans for the rapid execution of work acquainting with them the executives of all levels;

complete installation of all underground pipes and cables, and constructi on of roads and approaches before starting the erection of structures of the above-ground part of the building;

planning and taking the necessary steps to secure a constant stock of materials, structures and articles required for the construction of at least two floors;

planning and taking the necessary steps to ensure uninterrupted supply of electric power, mechanization and transportation means, and their reliable functioning;

organization of dispatching service, equipped with modern means of communications and control of the delivery of all kinds of materials and products from all suppliers;

construction of job-site storage facilities for the reserve mechanization and transportation means;

installation and testing of mechanization means for the erection and other operations.

3. Plans for the large-panel houses (for example, the 1kg-480-25 series and others) specify the extremely labor-consuming nonindustrial structures such as a sand bases for floors with concrete topping, large volumes of wet plaster, roofing material in rolls and others, which have to be eliminated because they do not correspond with the requirements of rapid work execution.

4. To ensure high quality execution of finishing work in the rapid construction it is necessary to make provisions for artificial drying of the building.

5. As a rule, house-building concerns and trusts operate without the reserve production facilities. Thus, whenever there is a lag in the production of structures and parts for the rapid erection of a house their shortage is made up at the expense of other construction sites. To eliminate the above-mentioned efficiencies it is necessary for the DSK to set up reserve production facilities.

6. The existing supply departments of the house-building concerns do not have sufficient storage space for storing of the necessary quantities of reserve prefabricated structures and articles, without which it is impossible to secure the continuous rapid execution of work. It is very essential that the DSK expands its existing storage facilities for the reserve-stock of prefabricated items and also that the funds are allotted for the construction of new shops of their supply department.

7. To improve the supply of material and engineering items to the rapid construction sites it is necessary;

to increase the reserve-stock quotas of materials, prefabricated structures and products;

to establish a steady provision of funds for materials and products

to organize engineering acquisition at all plants supplying products to the Trust.

8. The S-419 tower cranes used in the construction of large-panel, high-rise houses do not correspond with the requirement of rapid erection of buildings, because they require a lot of time and labor for their installation, dismantling and moving. Rapid construction sites should be provided with mobile cranes with revolving towers of the KB-100, KB-160-2 of KB-180 type.

9. A high technical and economical efficiency is achieved in the rapid construction. Erection time is reduced 3--4 times as compared with the standard method, labor-consumption is decreased by 0.3-0.5 man-day per 1m of living space and the net cost of construction is reduced by 4-5%. The number of simultaneously erected buildings, specified in the annual program of a building organization significantly decreases.

10. The rapid erection of building gives the opportunity to reveal the reserves and tight spots in the housing construction, which are recommended to be taken into consideration in the organziation of production line method of building the residential blocks and in the continuous production-line work organization of the DSK and the housing construction trust.

USSR DELEGATION AND ITINERARY

(Prepared in September 1969)

The tour of US Building Construction Industry is part of a technical exchange program conducted under terms agreed upon by the US Department of State and the government of the Soviet Union. The authorizing document is known as the "Agreement Between the USSR and the USA on Exchanges in the Scientific, Technical, Educational, Cultural and Other Fields in 1968-69."

This will be the second phase of an exchange between the two nations on "the Industrialization of the Building Process." During August and September, 1969, a delegation of American building construction representatives toured facilities in the Soviet Union as a first phase of the exchange.

The US Delegates were as follows:

DELEGATE	ORGANIZATION
Dr. James R. Wright (Chairman)	National Bureau of Standards Washington, D. C.
David Watstein (Interpreter)	Structural Clay Products Institute McLean, Virginia
W. Burr Bennett, Jr.	Prestressed Concrete Institute Chicago, Illinois
Charles J. Orlebeke	Department of Housing and Urban Development Washington, D. C.
Philip D. Bush	Kaiser Engineers Oakland, California
William W. Caudill	Caudill, Rowlett, Scott Houston, Texas
Charles C. Law, Jr.	General Services Administration Public Buildings Service Washington, D. C.
Fred W. Mast	The Associated General Contractors of America Washington, D. C.

The Soviet Delegates and escorts are as follows:

Aleksandr Maksimovich Tokarev
Minister of Industrial Construction of the USSR

Minas Georgiyevich Chentemirov
Construction Engineer, Deputy Chairman, Gosstroy

Nikolay Ivanovich Abramov
Construction Engineer, Chief Engineer, Leningrad Industrial Construction Project

Ivan Nikolayevich Dmitriyev
Construction Engineer, Consultant, Gosstroy

Oleg Georogiyevich Sergeyev
Senior Engineer of Foreign Relations Section, State Committee on Civil Construction and Architecture

Anatoliy Fedorovich Poluyanov
Director, All-Union Scientific Research Institute on New Construction Materials

Yuriy Grigor'yevich Aleksandrov
Manager of Construction Bureau

German Viktorovich Il'inskiy
Architect, Head Specialist on Planning and Urban Building, State Committee on Civil Construction and Architecture

US Escorts

William R. Herron
Technical Staff Assistant, Building Research Division, National Bureau of Standards, US Department of Commerce

Alexis B. Tatistcheff
Interpreter, US Department of State

The visit of this delegation is sponsored by the US Department of Commerce, with the National Bureau of Standards as host Agency. The Building Research Division of the National Bureau of Standards is coordinating the tour as the representative of the host Agency.

US DEPARTMENT OF COMMERCE

Staff

Secretary of Commerce
Honorable Maurice H. Stans

Assistant Secretary for Science and Technology
Honorable Myron Tribus

Director of the National Bureau of Standards
Dr. Lewis M. Branscomb

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Acting Director of the Institute for Applied Technology
Dr. Howard E. Sorrows

Acting Deputy Director of the Institute for Applied Technology
Malcolm W. Jensen

Chief, Building Research Division
Dr. James R. Wright

Deputy Chief, Building Research Division
Harry E. Thompson

The itinerary is aimed at providing an exchange of technical and scientific information between the USSR and the USA building industries, related to the topic "Industrialization of the Building Process."

The first two days have been designed to acquaint the delegates with the officials of the Department of Commerce and the Department of Housing and Urban Development. During this period there will be the opportunity to visit a new town, large residential construction activities, and an industries product development program.

On the third day of the program, the delegates will be given a daylight flight from Washington, D. C., on the Atlantic Coast to San Francisco, California, on the Pacific Coast and a free day in San Francisco. While in the San Francisco Bay area, the delegates will see academic and research facilities at the University of California and construction sites at Oakland. They will hear how systems design is applied and see a rapid transit system under construction.

In the greater Chicago area, the itinerary includes Forest Products research and fabrication of both industrialized and residential construction. Also included in this general area are roofing installation and nonprofit research laboratories for product improvement and voluntary system of production quality control.

In the Texas area both academic and research laboratories, and large scale construction sites will be visited.

Upon returning to the Washington, D. C. area, the delegates will devote a one-day trip to York, Pennsylvania, for the purpose of seeing the productions of mechanical systems of buildings. This itinerary was designed to show the delegates a wide range of climatic conditions and various urban environments.

ITINERARY OF THE USSR DELEGATION IN THE UNITED STATES

- NEW YORK -

Date	Agenda
October 1, Wednesday	Arrive and leave by air for Washington, D. C.

- WASHINGTON -

Date	Agenda
October 1, Wednesday	Evening arrival
October 2, Thursday	National Bureau of Standards, Gaithersburg, Maryland
	Reception and briefing, headquarters, American Institute of Architects
October 3, Friday	Levitt & Sons, Greenbriar Virginia
	Tour of Reston
	Tour of Structural Clay Products Institute
	Dinner guests of SCPI
October 4, Saturday	Departure by air for San Francisco

- SAN FRANCISCO -

Date	Agenda
October 4, Saturday	Afternoon arrival
October 5, Sunday	Sight-seeing in San Francisco
October 6, Monday	Earthquake Simulator, Richmond Field Station, University of California
	Structural Engineering and Structural Mechanics Department, University of California at Berkeley

October 6 (continued)	Kaiser Engineers tour, Oakland
	Reception at home of Philip Bush, American delegate on exchange visit to Russia and Kaiser official
October 7, Tuesday	Briefing by Building Systems Development
	Tour of Bay Area Rapid Transit (BART) Construction Station facilities in construction and completed; tunnel construction under San Francisco Bay
	Luncheon guests of BART
	Completed Berkeley station and aerial construction with linear parks
	Depart by air from San Francisco

- CHICAGO -

	Evening arrival
October 8, Wednesday	Visit Forest Products Laboratory facilities
	Depart for Milwaukee, Wisconsin, by station wagons

- MILWAUKEE -

	Inland-Ryerson Construction Products Co., Calumet Road Plant
	Inland-Ryerson Construction Products Co., Burnham Street Plant
	Dinner guests of Inland-Ryerson

October 9, Thursday	Visit with Langer Roofing and Sheet Metal, Inc.
	Depart for Northbrook, Illinois, by station wagons

- NORTHBROOK -

	Noon arrival; lunch as guests of Underwriters' Laboratories
	Tour Underwriters' Laboratories
October 10, Friday	Visit Portland Cement Association, Skokie, Illinois
	Depart via station wagons for East Chicago, Indiana

- EAST CHICAGO -

	Arrive early afternoon
	Tour Components Incorporated
	Reception with city and business officials, Jockey Club
	Depart for Chicago and flight to Houston, Texas

- HOUSTON -

	Night arrival in Houston
October 11, Saturday	Tour Rice University, School of Architecture and Engineering
	Tour Astrodome
	Tour of Jones Hall for the Performing Arts
	Dinner at home of William Caudill, member of the American delegation which visited Russia

October 12, Sunday	Air tour
	Tour in and around Galveston
	Regular tour of NASA facilities in Houston
October 13, Monday	Tour of 50-story reinforced concrete building, One Shell Plaza
	Tour of Caudill, Rowlett, Scott architectural offices
	Tour of Delta Concrete Products plant
	Tour of Stran Steel plan
	Depart from Houston by air for Austin, Texas

- AUSTIN -

	Evening arrival in Austin
October 14, Tuesday	Auto tour of HUD project, owner-occupied test site of 10 different designs of low-income housing
	House Evaluation Center, where sampling of low-income families are interviewed to determine user needs in low-cost housing
	Briefings on sociological aspects of housing project, the approach used in House Evaluation Center; auto tour of University of Texas campus
	Luncheon with city and University of Texas officials, Headliner Club

October 14 (continued)	Auto tour of construction projects on route to Balcones Reconstruction Center, Brackenridge Hospital, and Chevy Chase Center
	Briefing at Balcones Research Center
	Tour of Centers--Structures Fatigue, Research Laboratory, Civil Engineering Structural Research Laboratories
	Tour of residential area of West Austin
October 15, Wednesday	Leave Austin by air for return flight to Washington, D. C.

- WASHINGTON -

	Arrive early afternoon
	Tour Smithsonian Institution Museum
	Reception at new State Department building--officials from the Russian Embassy and the U.S. Departments of Commerce and Housing and Urban Development as well as State
October 16, Thursday	Trip to York, Pennsylvania

- YORK -

	Tour of Borg Warner plant and luncheon guests of York Division of Borg Warner
	Depart for Washington

- WASHINGTON -

	Arrive in evening; reception at Soviet Embassy

October 17, Friday	GSA/PBS-Tour of Federal construction in Washington area
	Luncheon guests of Associated General Contractors of America
	Minister received by Secretary Romney of HUD
	Closing ceremonies at the State Department
	Depart by air for New York for return flight to Soviet Union