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Modernization of the Soviet Steel Industry: What Lies Ahead?

An Intelligence Assessment

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SOV 87-10004X
January 1987
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Intelligence

Modernization of the Soviet Steel Industry: What Lies Ahead?

An Intelligence Assessment

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Modernization of the Soviet Steel Industry: What Lies Ahead?

Key Judgments

Information available as of 17 November 1986 was used in this report.

Modernizing the Soviet steel industry is crucial to the success of Gorbachev's industrial modernization effort. Without major improvements in the quality and variety of steel products, the General Secretary's program to develop and produce modern, technologically sophisticated machinery and equipment will be seriously hampered. Accordingly, Moscow has adopted a wide-ranging program for reequipping the Soviet steel industry and expanding the mix of output, specifically by:

- Reconstructing older steel plants.
- Replacing open-hearth steelmaking furnaces with basic oxygen or electric furnaces.
- More than doubling the share of steel continuously cast by 1990.

The steel modernization program focuses on elements that could lead to major improvements in product quality and cost reductions. Gorbachev has a strong incentive to push for progress in this important industry, but the cost of effectively carrying out the program during the 12th Five-Year Plan (1986-90) may outstrip the resources available for it. Replacement and renovation of steelmaking furnaces and rolling mills will require large investment outlays for new equipment and, in many cases, for new facilities to house the equipment at a time when national investment resources will be stretched thin by other demands of Gorbachev's economic revitalization effort. More important, domestic machine builders will be unable to meet the demand for more reliable and sophisticated metallurgical machinery until an improved mix of high-quality steel products starts rolling out of ferrous metals plants on a large scale.

Turning abroad for help, Moscow will find little near-term relief. Acquisition of modern Western equipment will be limited by reduced hard currency earnings, probably for the rest of this decade. Nor can the Soviets depend heavily on their East European client states for much additional machinery. These countries already supply Moscow with a large share of their machinery production and are ill prepared, and probably unwilling, to meet heavy new demands for more and better machinery exports

Thus, Gorbachev will have to assign as high an investment priority for the steel industry as for the machine-building and energy sectors if he hopes to make much progress in modernizing steel production. Large-scale domestic investments, if sustained for the next few years, would assure progress, particularly in raising the share of steel produced in modern furnaces or by continuous casting techniques. Completion of some of the new and

renovation projects planned during 1986-90 could help meet demands for higher quality products in key sectors of the economy, notably seamless pipe for the oil and gas sectors

On balance, we expect some progress in these areas. For example, greater use of modern furnaces and continuous casting will improve the efficiency of the steelmaking process during the late 1980s and help the Soviets meet their goals of increasing rolled steel output without increasing production of some inputs. In addition, less dependence on outmoded furnaces will give the Soviets more flexibility to produce additional quantities of specialized alloy steels.

Despite these improvements, however, the Soviet steel industry will face too many obstacles to meet the demands of the economy fully, at least for the remainder of the decade. As a result, we can expect to see:

- Continuing complaints from various ministries (especially the machine-building ministries) about inadequate variety and quality of steel products which, in turn, will inhibit progress in modernizing the machine-building sector.
- Machines that continue to outweigh their Western counterparts, perform fewer functions, and need to be repaired or replaced more often—thus siphoning scarce resources away from modernization and into capital repairs.
- Continued need for imports of many Western steel products, such as plate and sheet for the machine-building branches and pipe for the oil and gas industries, adding to the strain on dwindling hard currency resources

In view of the USSR's hard currency limitations and its need for modern equipment, Soviet planners will have to weigh carefully the trade-offs between purchasing Western plant and equipment to upgrade the technological level of the steel industry and importing Western steel products to meet the immediate needs of key machine-building sectors. Cutbacks in Western equipment purchases in favor of steel products, however, would further slow the pace of steel modernization and lengthen the Soviets' technological lag. The USSR is already behind Western Europe, Japan, and the United States in the development of innovative new technologies that will fundamentally change the way steel is made in the 1990s. Many of the new processes would be particularly beneficial to the Soviets because they offer flexibility in the use of raw materials, save energy, and cost less

per ton of installed capacity than conventional processes. Moscow may well decide to initiate within the next few years an aggressive program for the acquisition of these new processes through joint ventures or other arrangements that minimize the up-front outlay of hard currency. But the payoff from such a program would not materialize until well into the 1990s

In the meantime, the Soviet steel industry will achieve only moderate improvements and will continue to come up short in terms of both the regime's expectations and the needs of the machine-building sector. The failure to make major improvements in the steel industry over the next few years will make industrial modernization more difficult and protracted. As the Soviet leader is able to assess how modernization is faring, he may be in a position to better plan improvements that could be implemented in the 1990s. Prolonged delays and setbacks to current modernization plans, however, will also increase pressure on the regime either to back off its ambitious program or to make more fundamental changes in the system that might provide both the incentives and the resource slack necessary for meaningful improvements to occur

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The Importance of Steel to Gorbachev's Modernization Program

After all, even today the lag of the metallurgical industry is affecting other sectors. If we do not ensure a drastic improvement in the quality of metallurgical industry output, if the range of goods it produces does not meet present-day and future requirements, then we will be unable to achieve the necessary breakthrough in machine building and also . . . other spheres of the national economy.

Pravda *editorial*
13 November 1986

General Secretary Gorbachev's industrial modernization program requires the ferrous metals industry to improve sharply the quality and expand the variety of steel products provided to key sectors of the economy, particularly the machine-building and energy industries. Specifically, Gorbachev's program has raised the demand for hundreds of new and better steel products—from drill pipe for the oil and gas industries, to high-performance electrical sheet for transformers, and to special alloy steels for lighter, stronger, precision machine tools

The machine-building industry is the largest consumer of steel, and meeting its demand for steel products will be crucial to achieving Gorbachev's modernization goals. The increased rate of growth planned for machine-building output during the 12th Five-Year Plan (1986-90), coupled with Moscow's call for improving the quality of domestic equipment and conserving metal, requires steelmakers to both raise the quantity of output and produce a larger share of new high-quality steel products and products with special properties, such as stainless steel.

Sharply growing demand for more and better quality steel products in the oil and gas industries will add to the burden on the ferrous metals industry in the coming years. The oil ministry is planning to accelerate substantially the pace of development drilling and the number of oil well completions during 1986-90. The demand for drilling rigs, drill pipe, casing, and tubing will grow accordingly. In addition, plans to develop the deep sour oil and gas condensate fields of the Pre-Caspian Depression will impose stringent requirements on the steels used in the fabrication of production and processing equipment that can withstand extremely high pressures and temperatures as well as resist the corrosive environment found in these deposits

Finally, the defense sector will continue to demand more and better steel products as weapon systems now in the field are replaced with new ones whose performance characteristics require closer tolerances, lighter weight, and greater strength. Some weapon systems, especially armored vehicles, have traditionally consumed enormous quantities of steel, and CIA projections of growth in Soviet procurement of these systems suggest that steel consumption will be even greater in the future. Output of weapon systems requiring specialty steels—such as advanced fighter aircraft, which use alloys for wing boxes and landing gear; and new types of munitions, which contain specialty steel materials—is also projected to grow and will require the Soviet steel industry to produce larger quantities of advanced, higher quality steels.

A Troubled Industry

The steel industry is ill prepared to meet the challenge of Gorbachev's call for more and better products, because of both outmoded production facilities and perverse incentives that define success (and bonus allocations) more on the basis of tonnage than on type or quality of finished product. Indeed, the overall record of the steel industry during the past 10 years

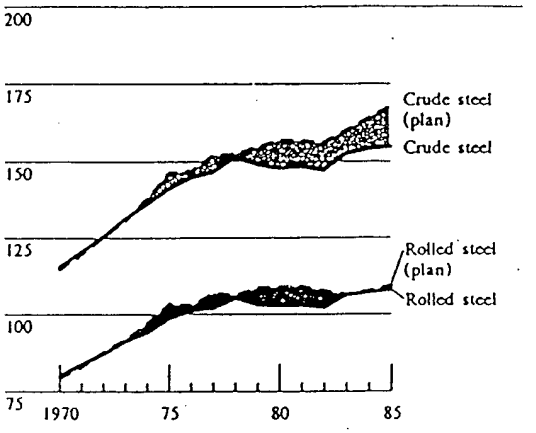
has been one of traditional failure to meet expectations, despite substantial imports of Western equipment and technology (see figure 1).[1] Previous regimes have called for steel mills to introduce hundreds of new varieties of high-quality rolled products, but the preponderance of poor-quality, out-of-date domestic metallurgical machinery has fostered low quality, narrow assortment, and shortages of steel products. As one leader in Soviet machine building characterized the situation in 1983:

> *The Ministry of Ferrous Metallurgy each year provides no more than 15 to 17 percent of the new forms of rolled steel required by our industrial branch, and the actual delivery record is still worse. During 1976-80, the enterprises of the Ministry of Heavy Transport Machine Building received only 43 of the 176 forms of rolled product that they required.*

The limited availability and variety of quality steels, in turn, result in poor reliability and low efficiency of domestically produced machinery and equipment. For instance, transformers built with poor-quality sheet have high energy losses, while new rolling equipment for steel mills suffers from frequent breakdowns. This results in large amounts of resources being allocated to capital repair instead of replacement. According to *Pravda*, for example, only about 2 billion rubles were spent on the development of metallurgical machine building in the last five years. In contrast, five times that amount was spent on the repair of metallurgical equipment during the same period.

Metal input and production costs for machinery and equipment are also higher because of the poor quality and narrow assortment of steel products. The Soviet press reports that replacement of unavailable shapes and sizes of rolled steel products with larger sizes is a widespread practice at machine-building enterprises. Additional waste occurs when equipment designers, with a distrust of steel quality, apply a "correction factor" to their designs. Largely because of these practices, machines in the USSR outweigh their Western counterparts by as much as 25 percent.

Figure 1
USSR: Planned Versus Actual Production of Ferrous Metals, 1970-85
Million tons



Gorbachev seized the opportunity during a conference on science and technology in June 1985 to criticize soundly the steel industry's past performance, putting the blame on inefficient allocation of capital investment. Half of the 50 billion rubles of investment spent by the industry during the past 15 years was channeled into new construction, largely to expand basic sectors such as iron ore mining and pig iron production at the expense of reconstructing downstream

[redacted]

production facilities to improve the quality and assortment of finished steel products.[2] As a result, the USSR has had to rely increasingly on imports to meet its domestic requirements for finished steel.[3]

Gorbachev followed up his criticism of the industry by sacking the Minister of Ferrous Metallurgy, Ivan Kazanets, in July 1985. His replacement, Serafim Kolpakov, who was first deputy of the Ministry from 1981 to 1985, has promised that modernization by "technical reequipment" would be the wave of the future (see inset).

The Current Steel Modernization Program

We have recently taken some far-reaching measures with respect to the cardinal issues of economic growth. I mean the resolutions calling for a fundamental reorganization of metal production....

Mikhail S. Gorbachev
at a June 1986 CPSU Central Committee meeting

With modernization of the steel industry almost as important as modernizing machine building itself, Moscow has adopted a wide-ranging program for reequipping the industry. The goals are to more than double the share of steel continuously cast by 1990, and to expand sharply the range of steel products manufactured. In comparison with past efforts that focused on increasing production capacities, the current plan emphasizes plant renovation and replacement of outmoded equipment, specifically by:

- Reconstructing older steel plants.
- Replacing old coke plants.
- Replacing open-hearth steelmaking furnaces with basic oxygen or electric furnaces.

[redacted]

According to the Soviet press, 50 percent of investment in ferrous metals during 1986-90 will be used to renew existing plants, 30 percent will go toward improving product variety and quality, and only 20 percent will finance capacity expansion. This is in sharp contrast with past five-year plans, which allocated up to 75 percent of investment to capacity expansion (see table 1).

The 1986-90 Plan provides further details on the new program's implementation. Overall gains in output are to be achieved not with increases in production of inputs—such as coke and pig iron—or in the size of the labor force, but with increases in labor productivity and resource savings (see inset, page 5). The emphasis on resource savings is illustrated in Moscow's call for average annual increases of 4½ percent in industrial production and 7½ percent in

[2] The term "reconstruction" is used loosely by the Soviets and includes replacement of equipment and facilities, renovation of existing equipment, and creation of completely new facilities to correct disproportions in capacities of various stages of the steelmaking process at a plant. According to the Soviet press, in recent five-year plans only 1 percent of investment went toward replacing iron-melting, steel-smelting, and rolling capacity. The few metallurgical machines taken out of service since 1975 were two to two and a half times older than their design life.

[3] The value of hard currency imports of finished steel products increased from about $600 million during 1966-70 to about $17 billion in 1981-85.

Table 1
USSR: Capacity Additions in Ferrous Metallurgy, 1976-85

Million tons

	1976-80 Annual Average	1981	1982	1983	1984	1985
Pig iron						
Total capacity	**1.1**	**0.4**	**0.3**	**0**	**0**	**0**
Reconstruction	0.2	0.4	0.3	0	0	0
New enterprises and expansion	0.9	0	0	0	0	0
Crude steel						
Total capacity	**2.9**	**1.3**	**2.4**	**0.3**	**2.2**	**0.9**
Reconstruction	1.1	0.1	2.4	0	0.1	0
New enterprises and expansion	1.8	1.2	0	0.3	2.1	0.9
Rolled steel products						
Total capacity	**1.5**	**2.2**	**0.8**	**1.6**	**1.5**	**1.3**
Reconstruction	0.1	0.6	0.2	0.2	0.4	0.4
New enterprises and expansion	1.4	1.6	0.6	1.4	1.1	0.9

Source: *Narodnoye khozyaystvo SSSR (Narkhoz)*, various years.

machine-building and metalworking output with less than a 2-percent average annual increase in rolled steel products during the plan period.[4]

According to statements by senior Soviet officials, priority in reconstructing steel plants during 1986-90 will be given to facilities constructed before World War II, such as those at Magnitogorsk (see table 2

- The Soviets plan to replace 30 million tons of open-hearth capacity with basic oxygen or electric furnaces over the next five years.[5] According to a Western metals journal, former Minister Kazanets stated that the widespread use of open-hearth furnaces—which are more costly to operate and more restrictive in output—constitutes the biggest bottleneck to improvement of the steel industry's overall performance. New facilities to house the new furnaces will have to be built at most, if not all, of these plants because existing structures are too small.
- All new steelmaking shops, including those at plants undergoing modernization, are to be equipped with continuous casting equipment.[6]

[4] During 1981-85, the annual output of rolled steel products rose by 1 percent per year while industrial production and machine-building and metalworking output increased only 2 and 1½ percent, respectively.

[5] There are three basic types of steelmaking furnaces: open-hearth, basic oxygen, and electric. In general, basic oxygen and electric furnaces permit the greatest control of temperature and chemistry and are best suited for producing high-quality steel. The Soviets still rely on the outmoded open-hearth furnace for more than one-half of their steel production, in sharp contrast with Western countries. In 1985, the United States produced only 7 percent of its steel in open-hearth furnaces, and none are now being used in West Germany and Japan.

[6] In the traditional steelmaking process, molten steel is poured from furnaces into large rectangular molds to form ingots. After cooling, the ingots are mechanically pulled away from the molds and placed into reheat furnaces to raise the temperature of the metal so the ingots can be rolled into primary shapes—slabs, blooms, and billets. In the continuous casting process—which the Soviets pioneered—molten steel is poured directly into molds from which primary shapes are directly cast and then rolled. This process saves energy and labor and produces steel that is more homogeneous.

The amount of steel continuously cast in the USSR has been growing at an average annual rate of 7 percent since 1970, to more than 18 million tons in 1983 (about 12 percent of total crude steel production), the last year for which data are available. This progress is modest when compared with the West where about one-third of US steel and over two-thirds of Japanese and West German steel is continuously cast. Because the maximum benefits of continuous casting are realized only when it is used with basic oxygen or electric furnaces, the slow replacement of open-hearth furnaces has limited the increased use of this technology. The lag in introducing more continuous casting equipment has also hampered Soviet efforts to improve yield—the ratio of rolled steel production to crude steel production—in steelmaking operations.

Savings of Rolled Steel Products

The 12th Five-Year Plan calls for total savings of 12-14 million tons of rolled steel, mostly in machine building and construction. If this target is achieved, total consumption in 1990 will be 12-14 million tons less than that which would have been obtained if 1985 efficiency standards had prevailed. Resource conservation has been espoused before, and the Soviets have achieved some recent success. A leading Soviet journal reported, for example, that the use of new types of steel for the walls and roofs of railroad freight cars during the last 10 years has reduced metal consumption by as much as 200 kilograms per car. In addition, design changes have reduced the weight of the load-bearing structures of freight cars by 20 to 25 percent. According to the official Soviet statistical handbook, the USSR achieved 93 percent of the rolled ferrous metals savings—8.6 million tons—designated for the 11th Five-Year Plan (1981-85).

Four recurrent themes appear in the Soviet press as ways to achieve the 1990 goal of reducing rolled steel consumption:

- *Reorganize the structure of rolled metal output and increase the relative share of "progressive forms" of steel products, including cold-rolled sheets, heat-treated steel, low-alloy steel, sheets with protective coatings, and high-precision shapes.*
- *Modernize the technology for the manufacture of steel products.*
- *Design equipment and facilities that make more efficient use of materials.*
- *Develop the use of substitutes for steel such as ceramics, plastics, chemical fibers, aluminum, and composite materials*

Greater use of numerically controlled machine tools and minicomputer-controlled, metal-cutting machinery would reduce waste from cutting steel sheet. According to the Soviet press, the use of heat-treated steel in machine building reduces steel consumption by 25 percent, and only 15 to 20 percent of demand for this steel is being satisfied. Although substitution possibilities in machine building are limited, the Soviets want to make additional use of aluminum and plastics to decrease weight and increase resistance to corrosion. According to another journal article, under Soviet conditions, 1 ton of plastic structural materials can replace as much as 4 to 5 tons of rolled steel in machine building.

Soviet press comments indicate that substitution will be the main method for saving metals in construction during the 12th Five-Year Plan. Greater use of ceramics, composites, and certain types of concrete not only can reduce consumption of steel, but can result in lighter, stronger structures. The potential for saving metal through other methods also is high. For example, a survey recently done by the USSR State Committee for Construction and the Ministry of Ferrous Metallurgy examined 432 designs for pipe systems in 11 branches of industry and found that many planned to use thick-walled pipe when it was not necessary. The Soviets estimate that more efficient use of steel pipe would result in an annual savings of about 370,000 tons

The USSR, however, probably will not be able to tap enough of this existing potential to reach the 12th Five-Year Plan savings target. A key to the success of the program is for the ferrous metals industry to provide the proper mix of steel products, but an Izvestiya *article in June 1986 reported that metallurgical enterprises had not fulfilled plan targets for the production of almost one-third of the economical types of metal this year. In addition, enterprises are unlikely to experiment with new designs, given the tremendous push for increased machinery production. For example, several machine-building ministries were criticized for backlogs in producing newly designed equipment that use less metal. A question also exists as to whether steel-consuming industries can handle certain high-quality steel shapes. For example, a change in the composition of metalworking equipment will be needed to make use of increased production of flat steel*

Table 2
USSR: Steel Modernization Objectives

Complex	Reequip or Build Coke Plants	Increase Capacity of Blast Furnaces	Replace Open-Hearth Furnaces	Increase Continuous Casting Capacity	Reequip or Build Rolling Mills	Build New Finishing Lines
Magnitogorsk ▪		•	•	•	•	
Dneprodzerzhinsk			•	•		
Kuznetsk ▪			•	•		
Novolipetsk		•			•	•
Petrovsk			•	•	•	
Liepaja ▪			•	•		
Orsk-Khalilovo	•	•	•	•		
Karaganda		•	•		•	•
Zhadanov (Ilyich)					•	
Serp I Molot					•	
Rustavi					•	

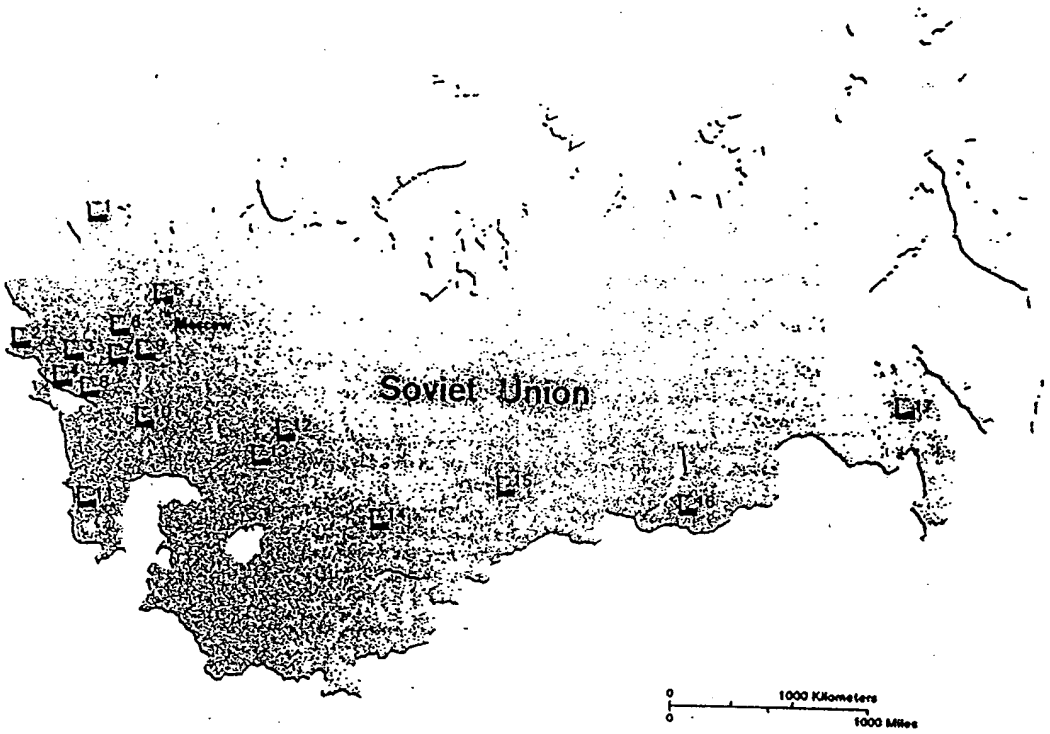
▪ Indicates that reconstruction projects are specifically mentioned in the 1986-90 Plan directives approved by the Supreme Soviet in June 1986.

- A Soviet journal reports that rolling mills and pipe-producing shops will be upgraded by removing outdated equipment, reconstructing some existing units, and creating new facilities. Chairman of the Council of Ministers, Nikolay Ryzhkov, has indicated that 70 rolling mills will be reconstructed and 38 will be decommissioned. Improvement of rolling mills is a key to providing the 500 types of new steel products called for in the five-year plan.

Although Soviet officials have indicated that Western firms would supply equipment and technology for many of the reconstruction and modernization projects, the US role is likely to be minimal. US equipment does not have a clear advantage in most steelmaking processes, and often Italian, Austrian, Japanese, and West German firms can offer superior equipment on more favorable financial terms.[1]

[1] Former Minister Kazanets expected a "significant" increase in cooperation with Western firms during 1986-90, but no large contracts for steelmaking equipment or technology have been signed with US firms since the contract to build the electrical-grade steel plant at Novolipetsk was dissolved. Under this contract, [redacted] was to supply the technology, laboratory testing equipment, and general engineering skills; and [redacted] was to provide the equipment. Both firms were prevented from carrying out the contract when US sanctions were imposed as a result of the Soviet invasion of Afghanistan. The Creusot-Loire group of France was subsequently awarded the contract in September 1980

Figure 2
Selected Soviet Steel Plants



1. Liepāja
2. Rybnitsa
3. Dneprodzerzhinsk
4. Zaporozh'ye
5. Serp i Molot
6. Orël
7. Oskol
8. Volzhskiy
9. Novolipetsk
10. Zhdanov
11. Rustavi
12. Magnitogorsk
13. Orsk-Khalilova
14. Karaganda
15. Kuznetsk
16. Petrovsk
17. Komsomol'sk-na Amure

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Table 3
USSR: Planned Capacity Additions to Selected Steel Plants Using Western-Origin Equipment, 1986-90

Plant	Supplier	Equipment	Value (*million US $*)
Volzhskiy (under construction)	Italimpianti (general contractor) and other members of the IRI-Finsider Group (Italy)	Electric steelworks with capacity of 1 million tons per year (tpy); continuous casting seamless tube plant with capacity of 720,000 tpy	975
Oskol (under construction)	Salzgitter (West Germany)	Pelletizing plant with capacity of 2-2.5 million tpy	90
	Korf Stahl (West Germany)	Four direct iron-reduction plants with total capacity of 1.7 million tpy	240
	Krupp (West Germany)	Electric steelmaking plant with capacity of 1.5 million tpy	189
	ASEA (Sweden)	Computer control equipment	26
	Schloemann-Siemag (West Germany)	Section mill with a capacity of 1.2 million tpy	268
Orel (under negotiation)	Krupp, Voest-Alpine (Austria), Italimpianti, and Clecim (France)	Electric furnace shop, continuous casting equipment, cold-rolling mill with 870,000-tpy capacity	NA
Zhlobin (under construction)	Voest-Alpine and Danieli (Italy)	Electric furnace shop modifications, vacuum degassing unit, a ladle furnace, continous casting equipment with 365,000-tpy capacity, a reversing roughing mill, modification of existing rod mill, and a 40,000-tpy mill for production of wire cord and bead for tires	400

Despite the emphasis on reconstruction, some new capacity is to be added in 1986-90 (see table 3). Most of these projects are slated to use Western equipment. Additional output is planned to come from a new minimill at Komsomol'sk in the Soviet Far East that uses Soviet and East German equipment and from a French-built, electrical-grade steel shop at Novolipetsk.[1] Both plants are scheduled to start production this year. The 1986-90 Plan also includes plans to commission new manganese and iron ore mining capacity to help offset production declines caused by falling ore grades and mine depletion in older basins.[1]

[1] A minimill is a relatively small steel plant that contains electric furnaces and continuous casting and rolling equipment. Because the raw material for steelmaking in a minimill is normally scrap, these facilities do not have the coke ovens or blast furnaces used to make pig iron at a fully integrated steel plant. The annual production of a minimill is usually between 50,000 and 500,000 tons of a limited variety of rolled steel products

[redacted]

Roadblocks to Modernization

Investment Constraint

The current steel modernization program seems to be focused on the right elements to improve Soviet steel production, but the cost of the program may outstrip the investment resources available for it:

- Emphasis on renovation and replacement of steelmaking furnaces and rolling mills could improve product quality and variety but will require large outlays for new equipment and, in many cases, unplanned expenditures for construction of new plant facilities to house the equipment.
- Western-supplied *turnkey* projects could be put into operation more quickly than either domestically supplied or Western-supplied *nonturnkey* facilities, but hard currency constraints probably will limit the number of such projects.

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- Stressing resource savings and increased use of steel scrap could limit the use of scarce raw materials, such as iron ore and coking coal, but substantial savings must await acquisition and installation of costly new, more efficient metallurgical equipment. Moreover, as in the past, investment may have to be diverted from improvement of rolling and finishing processes to the iron ore sector. During 1976-80 almost 30 percent of investment in the ferrous metals industry had to be allocated to iron ore production and beneficiation to offset the declining quality of ore.

Thus, while the Soviets seem to be attacking key problems that have long plagued the steel industry, success is dependent largely on how much investment can be made available quickly for renovating old plants and building new ones as well as for acquiring modern metallurgical equipment. Investment in ferrous metallurgy was slighted during 1981-85 and will have to increase sharply in 1986-90 to provide for the sector's modernization. Although Moscow planned to increase investment in ferrous metals by about 30 percent in 1986, it is doubtful that such an increase can be sustained during 1987-90. Increases in total investment throughout the economy are slated to average only 5 percent annually during 1986-90, and competition among the various sectors is keen. In a recent speech to the Supreme Soviet, Ryzhkov stated that 80 percent of the total increase in investment in 1986-90 will be allocated to support the Food and Energy Programs, the development of civilian machine building (presumably including metallurgical machine building), and expansion in output of electronic and chemical products

Production Constraint

Improving metallurgical machine building will be particularly difficult because the Soviet complex of steelmaking and machinery-producing industries are locked in a vicious circle of backward technology, poor quality, and inefficiency. Modern metallurgical machinery requires high-quality steel products that, in turn, rely heavily on improvements in the stock of metallurgical equipment. Making improvements in either industry, however, will require a good deal of slack in the system that gives producing enterprises and research institutes the time, the resources, and the incentives to develop, retool, and learn how to use new equipment and processes effectively. But Gorbachev's emphasis on an immediate acceleration in economic growth leaves little or no slack in any facet of the machine-building or steelmaking industries. Indeed, the increased pressure on plant managers to boost current production will inhibit innovation that carries any risk of failure and will reinforce the tendency to reproduce the same pattern of output that has prevailed for years, only faster and—unless major gains are made in quality control—perhaps in a more slipshod manner.

Moreover, qualitative improvements in metallurgical equipment production will be further inhibited because such equipment is not produced at specialized plants, but as a sideline at heavy-machine-building enterprises. *Pravda* reports that, at several of these plants, the proportion of metallurgical equipment in the total volume of output is declining. Workers and management at machine-building plants generally lack appropriate incentives for producing metallurgical equipment, especially the complex and labor-intensive machinery needed for rolling mills and finishing operations. Consequently, some machine-building ministries reportedly refuse to accept orders for the more productive machinery required by ferrous metals enterprises. At the 1986 party congress, the First Secretary of Chelyabinsk Oblast, the location of one of the largest Soviet steel complexes, specifically complained about the difficulty in obtaining equipment.

Special Problems of Renovation

In addition to the difficulties of supplying new and better machinery, a program based on reconstruction and technical reequipment poses particular difficulties for the steel industry. Managers of machine-building plants prefer to manufacture serial, standardized equipment, but, under the current modernization program, much of the new equipment must be custom made to fit into existing buildings at plants under renovation. Moreover, the renovation strategy has traditionally been resisted by managers of steelmaking enterprises because the downtime required to

replace old machinery, as well as the uncertainty inherent in new production processes, threatens their ability to achieve short-term performance goals. Renovation of rolling mills, for instance, usually requires that the facility be shut down.[10]

Of equal concern to enterprise managers may be how quickly workers adapt to the use of the new equipment, which often is more complex and requires more training to operate and maintain. To paraphrase a Soviet radiobroadcast, the Ministry of Ferrous Metallurgy intends to strengthen the training of the labor force by means of handing over experience from one worker to another and by sending people to special training courses. But intentions may not be enough. For example, [redacted] some workers at Novolipetsk, a plant that was included in the 1985 industrial management experiment and is currently being modernized, still lack the motivation and proper training to take care of sophisticated equipment."

Appropriate incentives must also be given to construction firms, which, according to a *Pravda* article, have generally steered clear of renovation projects because they tend to be more labor intensive than when construction is started from scratch. Many construction trusts are already suffering from labor shortages. A Soviet broadcast in mid-1985 reported that the Zhdanov Metallurgical Construction Trust, the main contractor for renovation work at the Azovstal' plant, was behind schedule in rebuilding a rolling mill because of a manpower shortage. Earlier in 1986, the Soviets reported a shortage of workers for assembling new rolling equipment at the Karaganda steel plant.

[10] In some instances, shutdown is not required. Because most new basic oxygen and electric furnaces will be housed in new facilities, the Soviets will be able to continue basic steel production from existing open-hearth furnaces until they are ready for replacement. After two basic oxygen furnaces are built at Magnitogorsk, for example, the Soviets report that an open-hearth shop at the plant will be phased out. Although this will help keep quantity up during renovation, it will do little or nothing toward improving quality in the usual drawn-out construction period.

[11] The Soviet experiment in industrial management launched under Yuriy Andropov in January 1984 was designed to increase productivity, promote innovation, and improve product quality by increasing the enterprise manager's incentive and ability to pursue these goals. [redacted]

Limited Help From Abroad

Given the difficulties the Soviets are likely to encounter with the domestic supply of modern metallurgical machinery, Moscow almost certainly will turn to its allies in the Council for Mutual Economic Assistance (CEMA), particularly East Germany and Czechoslovakia, to supply additional equipment. The Soviets have been importing East European metallurgical equipment for years, particularly for rolling mills, which generally is of better quality than domestically produced equipment (see table 4). East Germany's Sket has supplied about 30 rolling mills that manufacture 17 percent of Moscow's rolled steel products and is slated to renovate nine light-section rolling mills in the USSR during 1986-87. Sket currently is supplying the rolling equipment for the minimills at Rybnitsa and Komsomol'sk-na Amure. The Western press reports that the design for this equipment is similar to the rolling mill built by an Austrian firm at the Zhlobin minimill.

We are not sure how much additional high-quality equipment Eastern Europe can provide. Moscow already absorbs a large share of East European machinery production, and most of these countries lack the capacity to expand exports to the USSR much further without cutting into their exports to the West. Thus, it is unlikely that Moscow will be able to depend on its CEMA allies to compensate fully for the shortcomings of Soviet domestic machine building.

Undoubtedly, the Soviets will turn to the West to purchase equipment for some of the projects under way or planned, but they simply cannot afford to import all the needed equipment. The blow dealt to Moscow's main source of hard currency revenue by the collapse of world oil prices will limit Soviet foreign exchange spending to items of the highest priority, probably for the rest of the decade. In this context, most of the steel industry's projects for 1986-90 that are slated to use Western equipment are those that

Table 4
USSR: Imports of Metallurgical Rolling Equipment, 1975-85

Million US $

	1975	1980	1981	1982	1983	1984	1985
Total	211	486	429	579	443	404	446
Developed countries	90	184	157	244	199	109	184
CEMA countries	120	284	252	315	200	263	227
Czechoslovakia	72	193	165	193	127	109	127
East Germany	42	72	67	104	55	129	74
Hungary	6	19	20	18	18	19	26
Poland						6	
Other	1	18	20	20	44	32	35

Source: *Vneshnyaya torgovlya SSSR*, various years.

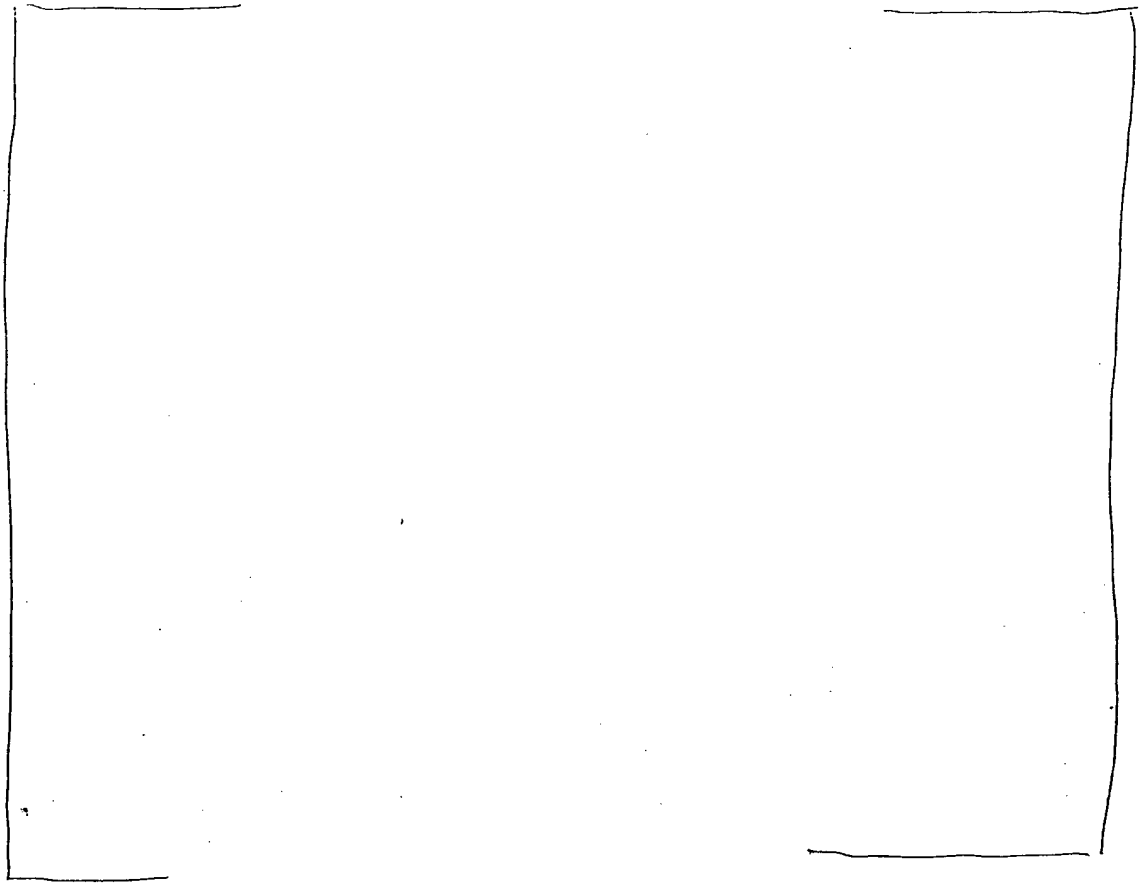
involve additions of new capacity and are already well under way.[12] Renovation projects, on the other hand, appear to be more vulnerable to cancellation. Soviet [redacted] plans for Western assistance to modernize the Zaporozh'ye steel plant, for example, have been canceled, and reporting on talks for reconstruction of other steel plants has tapered off in recent months.

The volume of future imports of Western equipment is likely to depend largely on the terms Moscow is able to negotiate with Western firms. Moscow has an excellent credit rating and may push for additional loans with lower interest rates and longer repayment terms for pending projects. For example, [redacted] the USSR was able to pressure the Italians for a loan with an extended maturity date and larger than that originally negotiated for the new steel plant at Volzhskiy.

[redacted] Soviet officials told representatives of an Austrian firm in early April that the priority of the Orel project, still under negotiation, had been downgraded, probably because of hard currency shortages. Recent reporting indicates that the Soviets have postponed awarding the contract. The decision, which was due in September, probably will not be made until 1987 and could be delayed indefinitely.

Even if all scheduled projects were fully funded, past experience shows that not all applications of Western equipment have gone smoothly. The Oskol Electrometallurgical Complex (OEMK) at Staryy Oskol, under construction by West German and Swedish firms, is a good example of how not to apply Western technology.[13] The OEMK is the only integrated steel project—with facilities for processing iron ore to producing finished rolled products—that has been started in the USSR in 15 years. The complex, originally scheduled to be completed in 1979, is only partially operational and probably will not be finished until 1988. [redacted] Although the reasons for the delays are numerous, many were because of the lack of a dedicated, Western general contractor. Problems included deterioration of equipment already delivered but not yet installed and construction delays caused by Soviet worker bonus systems that discourage timely installation and operation of new machinery.

[13] The first completed stage of the OEMK will produce about 1.5 million tons of high-quality structural, alloy, and bearing steel, probably for use mainly in construction and machine building.



Moreover, the Soviets are having a difficult time adapting to equipment that is already operating at OEMK [redacted] the tap-to-tap time—the time between pourings of liquid steel from the electric furnaces—was twice that of new electric furnaces in the United States, presumably because of poor worker discipline. In addition, a representative of a metals equipment firm indicated that Western engineers at the complex are fearful that Soviet technicians will not follow recommended equipment installation procedures, thereby increasing the risk of accidents and future technical problems. Similar Western equipment was damaged when it was improperly installed by the Soviets at the Novolipetsk

steel complex in late 1984.[ ]

[ ] the first electric furnace and direct reduction module at OEMK are not performing up to Soviet expectations.

In contrast, the construction and startup of the Zhlobin minimill by Western firms on a turnkey basis has been relatively successful.[9] Voest-Alpine of Austria was the general contractor, and firms from West Germany and Italy supplied equipment and technology to the mill, which was commissioned two months ahead of schedule. According to a Western metals journal, the plant was due to be operating near capacity in early 1984. The Soviets reportedly are so pleased with the Zhlobin mill that they have contracted with Voest-Alpine and the Italian firm Danieli to expand the plant—again on a turnkey basis.[10]

The contrast illustrated by these two examples may have influenced Moscow's recent decision to allow greater Western participation in future joint-venture projects, including foreign equity, increased management and quality control, repatriation of profits, and other prerequisites, to make such ventures attractive to Western firms. Such arrangements could have several advantages for the Soviets:

- A management role for the Western firm would facilitate the transfer of technical know-how related to organization and management of production and the use of advanced technology, knowledge not easily transferred through traditional equipment purchases.
- A long-term equity relationship with a Western firm could allow for automatic updating of production lines to keep up with changing Western steelmaking technology. At a minimum, a vested interest by the Western firm—backed by sustained on-site presence—could improve the use of Western equipment and technology.
- Quality control by the Western partner could help assure that steel products come close to, if not meet, world standards.
- Such arrangements would allow for the transfer of Western technology at little or no hard currency cost to the Soviets until after production begins.

Despite these potential advantages to Moscow, Western steel firms are unlikely to rush to enter into such joint ventures. Years of dealing with the cumbersome Soviet bureaucracy, poor-quality Soviet raw materials and semifinished goods, and negotiations that go on interminably will make most Western businessmen wary. Moreover, the Soviets themselves are apt to approach such negotiations cautiously. Granting the amount of control over production processes that would probably be required by the Western firms would go against the grain of most Soviet managers. At present, it appears that there is still a considerable amount of uncertainty among midlevel Soviet officials over exactly what such joint ventures would entail.

Outlook and Implications

On balance, we believe that the Soviets will fall short of meeting the modernization goals for the steel industry, although we expect some progress to be made. A greater share of steel will be produced in modern furnaces—basic oxygen and electric—and more of this steel will be continuously cast. These steps will improve the efficiency of the steelmaking process and help the Soviets meet their goals of

[ ] the Novolipetsk steel complex also is plagued by mismanagement and the inability of Soviet engineers to assimilate new Western technology. Western technicians expect the new equipment now being installed, some of which uses state-of-the-art technology, to break down shortly after commissioning because of the shoddy workmanship of those responsible for maintenance.

[9] The Zhlobin facility consists of two electric-arc furnaces with a designed annual capacity of 700,000 tons of crude steel, a continuous caster, and a combined bar, rod, and section rolling facility with a capacity of 500,000 tons per year.

[10] Recent Soviet reporting indicates that operation of the Zhlobin plant has not been as successful as construction and startup. Poor management and worker discipline have resulted in inadequate production of high-quality products. One-third of the workers at Zhlobin have been criticized for violating technical discipline and producing defective output. During the first six months of 1986, the plant failed to fulfill about 8,000 orders for finished products.

increasing rolled steel output without increasing production of some inputs, which is essential if investment is going to be concentrated on upgrading metallurgical equipment. Moreover, less dependence on outmoded open-hearth furnaces will give the Soviets more flexibility to produce additional quantities of specialized alloy steels, which cannot be produced in these furnaces.

Completion of some of the new plants and renovation projects planned during 1986-90 may help meet demands of key sectors of the economy. For example, when the new plant at Volzhskiy reaches full capacity, it will provide almost 10 percent more seamless pipe to the economy than was produced in 1985. Moreover, pipe from this plant should prove more reliable in the oil and gas industries and could lead to fewer delays in drilling and developing new oil wells

Despite some improvements, the Soviet steel industry will face too many obstacles to meet fully the demands of the economy during 1986-90. In addition to problems with domestic machinery supply and factors within the system that are likely to inhibit renovation, Moscow will not be able to count on much help from its CEMA allies or on a sharp upsurge in purchases of Western equipment and technology. If the stock of metallurgical plant and equipment is not modernized on a large scale, the industry's ability to conserve raw materials will be limited, and investment will have to be channeled into expanding iron ore production and beneficiation. As a result, the amount of new and better steel products flowing from the industry will fall well below that demanded, and we can expect to see:

- Continuing complaints from various ministries (especially the machine-building ministries) about inadequate variety and quality of steel products, which, in turn, will inhibit progress in modernizing the machine-building sector—the centerpiece of Gorbachev's industrial modernization program.
- Machines that continue to outweigh their Western counterparts, perform fewer functions, and need to be repaired or replaced more often—thus siphoning scarce resources away from modernization and into capital repairs.
- Continued need for imports of many Western steel products, such as plate and sheet for the machine-building branches and pipe for the oil and gas industries, adding to the strain on dwindling hard currency resources.

Moscow's continued dependence on Western imports for quality steel products will be particularly vexing to the leadership in view of its hard currency limitations. In the past, Moscow has been able to afford both steel products and steelmaking equipment. Since 1975, the USSR has ordered over $4 billion worth of Western steelmaking equipment and technology and has spent more than $30 billion on imports of Western steel sheet, plate, tube, and pipe. With a sharp decline in hard currency earnings facing the regime for the foreseeable future, sustaining these levels of purchases is likely to be difficult. Soviet planners will have to weigh carefully the trade-offs between purchasing Western plant and equipment to upgrade the technological level of the steel industry and importing Western steel products to meet the immediate needs of key machine-building and energy-producing sectors.

Cutbacks in Western equipment purchases in favor of steel products would further slow the pace of steel modernization and widen the gap between Soviet and Western steelmaking technology. Even if the Soviets opt to continue purchases of Western steelmaking equipment, progress in modernizing the USSR's steel industry is not likely to proceed fast enough to keep pace with developing technologies in the West. Indeed, research now under way in Western Europe, Japan, and the United States promises innovative new technologies that will fundamentally change the way steel is made in the 1990s (see table 5).[1] Thus, the Soviets are likely to remain well behind the West in steelmaking technology and will need to continue playing "catch-up ball," either through their own

Table 5
Selected Soviet Advanced Steelmaking Technologies

Technology	Description	Major Advantages	Status in West
Direct-current arc furnace	Process in which a direct current passes down an electrode through an arc into the metal charge	33- to 50-percent reduction in electrode consumption Less frequent need for refractory maintenance Small degree of energy conservation	Limited-scale commercial application
Continuous-charging electric furnace	Process in which raw materials are added on a continuous rather than a batch basis	150-percent increase in labor productivity 30-percent reduction in electricity consumption 40-percent reduction in electrode consumption 50-percent reduction in manpower costs	Limited-scale commercial application
Combined-blowing oxygen furnaces	Steelmaking processes that combine the advantages of top-blowing and bottom-blowing oxygen furnaces	Flexibility for greater scrap usage	Development and limited-scale commercial application
Ladle metallurgy (argon-oxygen decarburization, vacuum degassing and refining, and electron-beam remelting)	Processes that remove impurities from either molten metal poured directly from conventional furnaces or remelted steel	Increased quality control Increased labor productivity	Used extensively for alloy steel production, but gaining wider use in production of carbon steel
Horizontal continuous casting	Continuous casting process that uses horizontal molding machines rather than curved	Decrease in internal cracks Reduction of inclusions More efficient at producing smaller products	Limited-scale commercial application
Hot charging and direct charging to the hot-rolling mill	Hot charging allows only some cooling, followed by a minimum of reheating, before charging to the rolling mill. Direct charging process sends the semifinished steel directly from the casting machine to the rolling machine without reheating.	Substantial energy savings Increase in yield	Advanced R&D
Direct iron smelting	Process to replace blast furnaces and coking and sinter plants. Iron reduction is carried out in a separate chamber from smelting, allowing gasification of ordinary coal both to create reduction agent and heat needed for smelting.	Reduction in operating costs Reduction in capital costs Use of ordinary coal instead of metallurgical coal	Pilot plant (contract awarded in 1985 to build first commercial plant)
Near-net-shape casting	Process to extend today's continuous casting of semifinished steel to cast either a thin slab 1 to 2 inches thick or to directly cast steel strip 0.1 inch in thickness	Substantial energy savings Reduction in labor costs Reduction in capital costs Improvement in quality	Testing (commercial application of thin slabs, three to five years; thin strip 10 to 15 years)

research and development (R&D) or by efforts to acquire these technologies from the West. Soviet domestic R&D efforts have only scratched the surface in some of these technologies. Even when Soviet R&D efforts are successful (for example, horizontal continuous casting), the past record suggests that development does not quickly lead to widespread application. Moreover, because some of these advanced steelmaking technologies require sophisticated computer control systems, Soviet indigenous development of the process technology would have to await acquisition or development of the control systems, some of which would probably fall under COCOM controls.

Nevertheless, the Soviets will want to pursue these new technologies because they offer flexibility to use more abundant resources or save on energy use.[14] Direct iron smelting would be especially beneficial for the Soviet steel industry because it eliminates the need for coke. Shortages of coking coal have constrained Soviet steel production for some time, and we expect this problem will grow worse in the future. Technologies such as near-net-shape casting, continuous-charging electric furnaces, and hot or direct charging for rolling mills promise substantial energy savings. Moreover, many of these new technologies cost less per ton of capacity than conventional processes. Soviet steel authorities are likely to be attracted to any technology that not only cuts operating costs but also stretches limited investment funds. Thus, within the next several years we can probably expect Moscow to initiate an aggressive program to acquire these technologies through joint ventures or other arrangements that limit the up-front outlay of hard currency. But the payoff from such a program would not materialize until well into the 1990s

[14] The Soviets are already working with West Germany's Krupp Industrietechnik to develop a 100-percent scrap-based basic oxygen furnace to limit the use of iron ore

In the meantime, the Soviet steel industry will continue to come up short in terms of both the regime's expectations and the needs of the machine-building sector. The failure to make major improvements in the steel industry over the next few years will make industrial modernization more difficult and protracted, increasing the risk that Gorbachev's ambitious modernization goals for the remainder of the decade will not be met. As the Soviet leader is able to assess how modernization is faring, he may be in a position to better plan improvements that could be implemented in the 1990s. For example, he could double the value of imports of Western equipment—by increased borrowing in the West—to modernize steelmaking without increasing the share of domestic investment resources for steelmaking and finishing processes.[15] Prolonged delays and setbacks to current modernization goals, however, will also increase pressure on the regime either to back off its ambitious program or make more fundamental changes in the system that might provide both the incentives and the resource slack necessary for meaningful improvements to occur.

[15] A doubling of imports of Western equipment would account for about one-fourth of investment targeted for the steelmaking and finishing processes. This calculation is derived from several assumptions based on past experience: one-half of the 3 billion rubles devoted to ferrous metallurgy annually is allotted to steelmaking and finishing processes; imports of Western steelmaking equipment have averaged about $400 million a year; and the ruble-dollar ratio for metallurgical equipment, based on an unweighted and limited survey, is roughly 0.5. Ruble-dollar ratios were not adjusted for differences in performance capabilities, quality, or scale of production.