During manufacture of sheets of 1Kh21N5T steel at the Zaporozhstal' Plant, there used to be brittle rupture of the hot-rolled strips when the rolls were unwound in front of the throughway continuous-quenching furnace at the cold-rolling shop. Cracks appeared midway across the strip and in certain cases extended as far as the edge of the sheet. It was shown that the brittleness was due to delayed cooling of the strip at 600-400°C and was evidently linked with 475-degree brittleness inherent in ferrite steels and steels of the ferrite-austenite class containing a large amount of ferrite component and possessing a large-grain structure.

Study of the strip metal from the same melt in brittle and plastic states showed that the reason for a structure with a large amount of ferrite phase was overheating of the ingots above 1250°C. Heating metal from the same melt to lower temperatures (1180°C) helped to retain austenite which hampered grain growth in the structure of the steel. Strips of this kind showed a fine-grain structure and no great tendency toward brittle rupture.

To study the tendency of 1Kh21N5T steel toward embrittlement, we used sheet specimens from two industrial melts differing in titanium content (the chemical composition is shown in Table 1). Specimens were quenched in water from 1100 and 1250°C (soaking for 30 min) and tempered at 400-850°C.

The metal from melt 1 with a higher titanium content (0.65%) has a purely ferritic structure after heating to 1250°C; the structure of metal from melt 2 (0.55% Ti) retained about 10% austenite after heating to the same temperature.

As can be seen from Fig. a, in steel from melt 1 with an initial ferritic structure (quenching from 1250°C) after tempering at 400-600°C, the hardness is increased and plasticity decreased. At higher tempering temperatures (650-850°C) the steel gradually acquires mechanical properties close to the initial ones. Metal from the same melt with an initial two-phase structure (quenching from 1100°C; Fig. a) is less inclined to brittleness during tempering, but at 475°C we observe a sharp increase in strength and hardness, while the plasticity declines.

Metal from melt 2, quenched from 1250°C, also shows a tendency toward brittleness after tempering at 450-600°C, but much less so than in melt 1 (see Fig. b).

Sheet specimens from melt 2 retain mechanical properties close to the initial ones after quenching from 1100°C and further tempering at 475°C. No changes were observed in the structure of the steel (for a magnification x 1000) after tempering at 475°C.

The process causing embrittlement of the overheated steel after tempering at 400-600°C is reversible. After repeated heating at 750-850°C the mechanical properties are restored and secondary austenite (γ′) is formed in the structure from the α-solid solution.

To establish the relationship between susceptibility to embrittlement in the metal after tempering and the chemical composition of the steel, we compared variation in the mechanical properties of the steel and the content of various chemical elements. It was found that at 4.8-5.3% Ni and 0.09-0.11% C the greatest effect on susceptibility to embrittlement is shown by excess titanium (more than 0.15% of the minimum required according to the equation Ti = (% C-0.03)S) (Table 2).
To study the susceptibility of the steel with an altered chemical composition to embrittlement we determined the mechanical properties of cold-rolled sheets after tempering at 550°C for 1 h and the impact strength of non-standard specimens from hot-rolled sheets.

For the melts containing 0.25-0.50% Ti we established a more accurate regime for heating the metal in all sections, on the basis of which a technological procedure was adopted similar to the one for Kh18N10T steel.

The microstructure of slabs and sheets containing 0.25-0.50% Ti consists of austenite and ferrite in the proportion 1:1. After heating to 1200-1300°C there is a decline in the quantity of austenite, but even at 1300°C it amounts to 10-15%. The impact strength after quenching from 1200, 1250, 1270, and 1300°C is 12-15 kgm/cm². Even after further tempering at 550°C there is only slight change in the impact strength.