Comprehensive Approach to the Decommissioning of Oil Pipelines

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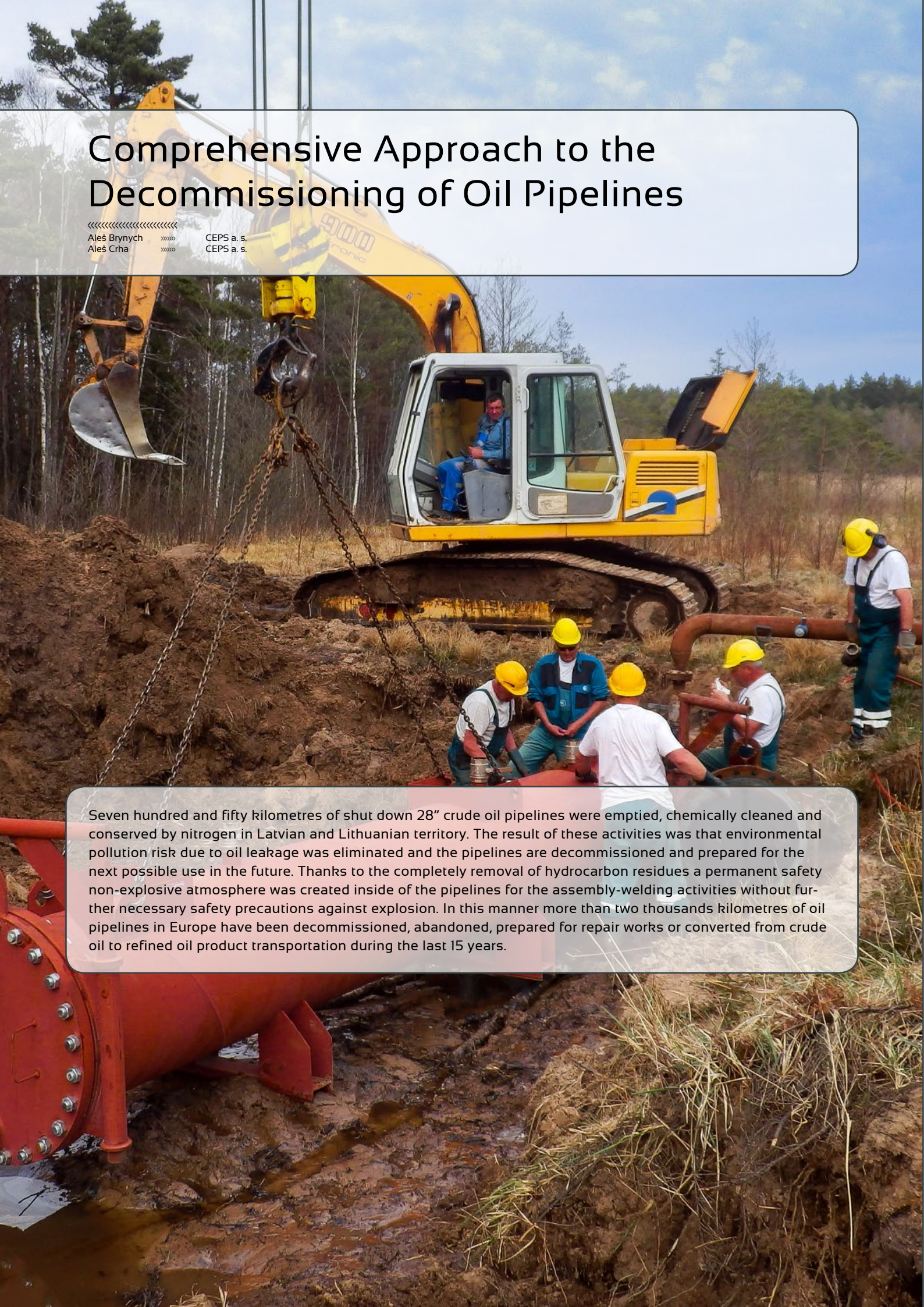

Seven hundred and fifty kilometres of shut down 28" crude oil pipelines were emptied, chemically cleaned and conserved by nitrogen in Latvian and Lithuanian territory. The result of these activities was that environmental pollution risk due to oil leakage was eliminated and the pipelines are decommissioned and prepared for the next possible use in the future. Thanks to the completely removal of hydrocarbon residues a permanent safety non-explosive atmosphere was created inside of the pipelines for the assembly-welding activities without further necessary safety precautions against explosion. In this manner more than two thousands kilometres of oil pipelines in Europe have been decommissioned, abandoned, prepared for repair works or converted from crude oil to refined oil product transportation during the last 15 years.

COMPREHENSIVE APPROACH

Combination of product displacement and subsequent chemical cleaning of pipelines transporting hydrocarbon liquids is the most effective, quick, safe and environmentally responsible pipeline cleaning solution that makes many pipeline decommissioning, remedial repair, revalidation, conversion or abandonment projects feasible because it reduces the needed shut-down time, costs and also significantly enhances safety of works.

During last 15 years CEPS used this method on more than 2000 km of 4" to 28" high pressure oil pipelines in Europe for different projects like:

- Decommissioning of unused crude oil pipelines, their conservation and integrity tests for a future use,
- Short term shut-downs of pipeline sections for multiple repair works,
- Conversion from crude oil to refined oil product service and others.

Some of the projects are described below with simply demonstration of technology and benefits of the comprehensive approach.

DECOMMISSIONING AND CONSERVATION OF CRUDE OIL PIPELINES FOR THEIR FUTURE USE

The crude oil transport through 28" pipeline system Polock – Ventspils and Polock – Mazeikiai on the territory of Lithuania, Latvia and Belarus was terminated more than 10 years ago. (See Figure 1 – Pipeline routes.) These pipelines in the total length of almost 1000 km remained full of the oil containing about 2.4 million barrels of oil.

This situation had very bad consequences for pipeline operators as their responsibility for costly maintenance and environmental risk in cases of pipeline damage caused by a corrosion or a third party remained.

At the same time this situation prevented any other use of the pipelines like transmission of refined oil products or natural gas.

For these reasons pipeline operators in Lithuania and Latvia decided to decommission 750 km of these pipelines step by step that included emptying, chemical cleaning and conservation.

Both these pipelines are lead for about 170 km from Belarus border on the territory of Baltic States in parallel.

Beyond the Biržai pumping station they separate and one of them routes for 230 km to the Ventspils oil terminal on the Baltic Sea shore and the other to the 160 km distant oil refinery at Mazeikiai.

On request of pipeline operators CEPS worked out the engineering study of emptying, cleaning and conservation of these pipelines for their potential future use and in an international tender was nominated a general contractor.

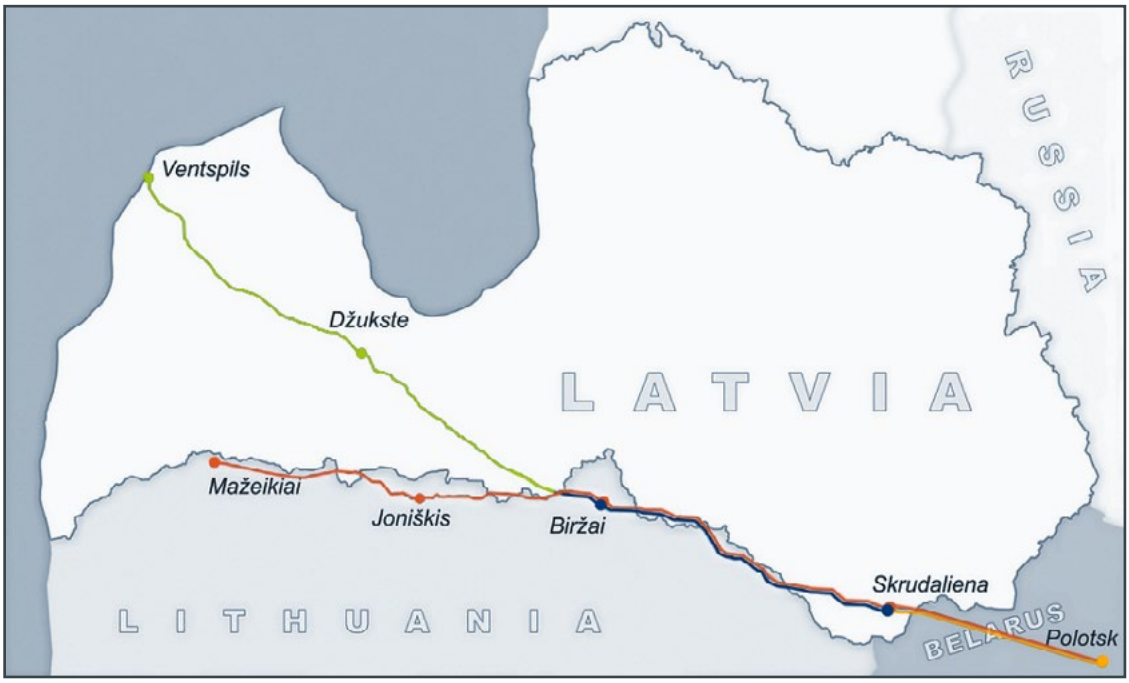

Figure 1: Pipeline routes

PREPARATION WORKS

For emptying the pipelines were divided into a total of 11 sections. Existing launching and receiving pig traps were used when possible and to the remaining section ends a CEPS temporary launchers/receivers were installed (Figure 2).

Figure 2: CEPS temporary launcher trap

Pipeline operators made all excavation and welding work as well as HT&P isolation of decommissioned pipeline parts by their own equipment and personnel.

PIPELINE EMPTYING

Two pigs were inserted into each launcher and a water batches were created by pumping water in between them. These water batches were then propelled through pipeline sections by inert nitrogen mixture containing more than 90% of nitrogen. Two CEPS mobile nitrogen generators produced sufficient volume of nitrogen to move the water batches and the whole content of the crude oil through the pipeline sections (Figure 3).

Figure 3: CEPS mobile nitrogen generators

According to the customer requirements a part of the crude oil was moved this way to reservoirs in the Mazeikiai oil refinery in Lithuania and the another part to the Ventspils oil terminal in Latvia.

At the beginning of empting the lines from Belarus border it was always necessary to bring into the movement a mass of crude oil in the length up to 330 km that was in the pipeline for several years with no movement.

The longest pipeline sections were 180 km, 2 × 150 km, 130 km and 80 km. This was possible because the elevation profile was relatively flat and the crude oil with low content of paraffin.

On the pipeline section between Belarus border and the Birzai pumping station there are several interconnections with leaking valves that could cause leaking of crude oil from a full pipeline to already emptied parallel pipeline. Instead of costly blinding of these interconnections we managed to empty both parallel 150 km pipeline sections at the same time and drive the both emptying pig trains by the same velocity in both pipelines so that this risk was eliminated.

CHEMICAL CLEANING OF THE PIPELINES

The aim of the chemical cleaning was to clean the internal pipeline surface from crude oil rests so that no environment pollution would occur in case of future pipeline damage. By removing the hydrocarbons the permanent explosion safe conditions in the pipeline allow future flame cutting, grinding and welding works to be done safely without costly and time consuming preparatory work to create safe conditions.

For the chemical cleaning special temporary CEPS launchers and receivers were fastened or welded to both ends of each cleaning section (Figure 4 and 5).

Technicians inserted several cleaning pigs to each launcher and pumped a predetermined amount of CEPS PETROSOL 1 agent to create cleaning batches with different fixed agent concentrations. The final batch of each cleaning train was water. These cleaning trains were propelled through cleaned pipeline sections with compressed air.

After that the internal pipeline surface remained completely clean without rests of crude oil (Figure 6).

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Figure 4 and 5: Temporary traps for chemical cleaning

Figure 6: Internal pipeline surface after chemical cleaning

Figure 7: Temporary reservoirs

Samples of water from the last water batch of each pig train were taken after its arrival to the receiver in order to establish the remaining content of hydrocarbons. The analyses done in an accredited testing laboratory never showed exceeding the concentrations required by local standards.

Disposal of used cleaning batches in the total volume of about 13 000 m³ was done following way:

- CEPS disposed 3 000 m³ to Mazeikiai refinery water treatment plant,
- CEPS disposed another 10 000 m³ pumping them into temporary reservoirs in Džukste and Skrudaliena pumping stations (Figure 7) using a biodegradation cleaning method. The hydrocarbons concentration in water after the cleaning reached 0.6 mg/l and therefore it was possible to pump this water into the river.

"The Combination of displacement and subsequent chemical cleaning of pipelines makes remedial repairs, revalidation, decommissioning and abandonment projects significantly quicker, cheaper and safer."

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CONSERVATION OF THE PIPELINE

After completion of the chemical cleaning the pig traps were flame cut from the pipeline, the interconnections of the pipeline sections were made and free ends were blinded by cups. It was possible to make all these welding and cutting jobs safely at permanently explosion safe conditions (Figure 8) that considerably improved the efficiency of the work.

Figure 8: Flame cutting at permanently explosion safe conditions

Pipeline conservation for the protection against a future corrosion was made in two steps.

First phase (passivation of the internal pipeline surface) was done already during the chemical cleaning as a corrosion inhibitor was mixed in the last water batch used.

In the second phase after the chemical cleaning the pipeline was purged by the nitrogen mixture containing 95% of nitrogen. After that the nitrogen pressure in the whole pipeline system was increased to 3 bar. To do that CEPS used its mobile nitrogen units again (Figure 9).

Figure 9: Production of nitrogen mixture on the jobsite

BENEFITS

Above procedure of emptying, chemical cleaning and conservation brought following benefits to the pipeline operators:

- Permanent elimination of the pollution risk caused by a oil leak from the pipeline in case of its damage by corrosion or a third party intervention,
- Creating of permanent explosion safe conditions in the pipeline eliminating the explosion risk during any future work on the pipeline or any third party intervention,
- Readiness of the pipeline to a future integrity revalidation (pressure test) and possible use for transport of another product if needed,
- Considerable decreasing of future maintenance and protection costs,
- Possibility of the continuous pipeline tightness check by a pressure monitoring,
- The last but not least – considerable financial benefit from utilisation of the crude oil from the pipeline.

VERIFICATION OF THE CLEANNESS OF THE PIPELINE DURING THE SUBSEQUENT REVALIDATION

A revalidation of an 8 kilometre section of this 28" pipeline near Džukste pumping station in Latvia was done in 2013 in order to obtain data needed for a strategic decision about a future use of this pipeline.

In the process of the revalidation a repair of some known defects, hydrostatic test and TFI pipeline inspection in an off-line regime was done. The TFI inspection tool was propelled through the pipeline section by water.

The quality of previous chemical cleaning was thoroughly checked during these works.

No safety precautions to create safe conditions for welding on this pipeline were necessary and also chemical analysis of water used for hydrostatic testing and internal inspection did not show any contamination and therefore it was possible to drain it into the river.

SHORT TERM PIPELINE SHUT-DOWN FOR MULTIPLE REMEDIAL REPAIR WORKS

For more than 10 years CEPS successfully carries out comprehensive repairs of high pressure pipelines with replacement of many defective components and/or hydrostatic testing. In such cases it is very convenient to empty the pipeline with nitrogen and chemically clean the internal pipeline surface.

Than a time consuming local draining or expensive multiple isolation of pipeline section by HT&P or by using of isolation pigs, gas bags, clay plugs etc. is not necessary. After the chemical cleaning the conditions inside the pipeline are immediately safe for welding and any other work. This makes the repairs easier, faster and cheaper. The repairs can be done simultaneously on many locations, needed shut-down time is much shorter, and start of the operation after the job easier as there are no multiple isolation pigs or gas bags and no dirt from multiple clay plugs in the pipeline. Subsequent hydrostatic testing is then possible without any risk of pollution and the testing water can be easily disposed.

REPLACEMENT OF 32 PIPES IN 96 HOURS

One of many examples of this approach is the repair of 21" Druzhba crude oil pipeline in Czech Republic, where CEPS replaced 32 pieces ten-meter long defective pipes spread on about 10 km of the pipeline in 4 days. During first 2 days the pipeline was emptied and chemically cleaned and during next 2 days the defective pipes were cut out and replaced. In total 16 welding crews were working simultaneously on the pipeline, each crew replaced 2 pipes. The spread of some jobsites is shown in Figure 10.

REPAIR OF MANY DEFECTS DURING SHORT TIME SHUT-DOWN

The other examples are repairs of product lines in Czech Republic made usually during planned shut downs. Old 8" to 12" pipeline sections of the length of 50 to 90 km are shut-down for about 15 days and after draining and chemical cleaning repairs of about 100 defects are made in different pipeline locations. In cases of subsequent hydrostatic retesting the shut down time of such a pipeline section is maximum 30 days.

Figure 10: Spread of some jobsites

THE CONCLUSION

Combination of displacement and subsequent chemical cleaning of pipelines makes remedial repairs, revalidation, decommissioning and abandonment projects significantly quicker, cheaper and safer. Many repair works would not be even possible in allowed shut down time and with required level of safety without it. Instant achieving of the explosion-safe conditions after the chemical cleaning enables to repair or replace a number of pipes or pipeline components with flame cutting and welding in a remarkably shorter time. Therefore the needed downtime, costs and all risks are reduced significantly.

The risk of test water contamination with product remaining in the pipeline during hydrostatic retesting is eliminated.

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