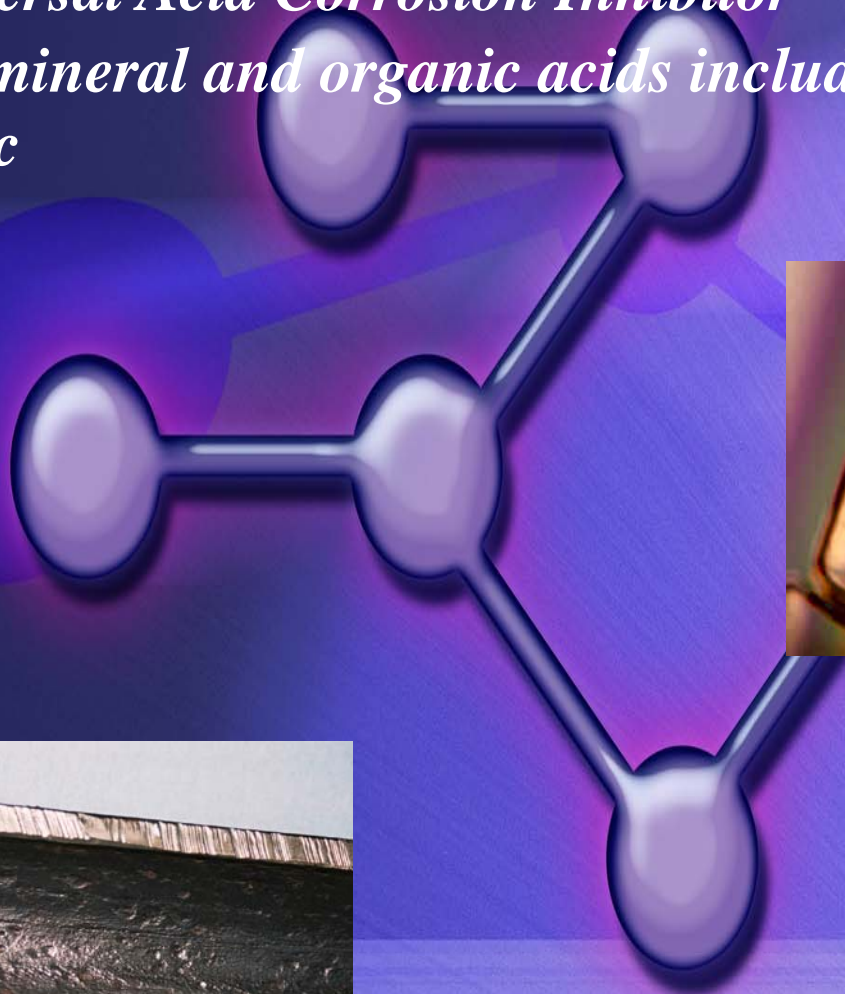


Paratene™ ACI

*Universal Acid Corrosion Inhibitor
For mineral and organic acids including
Nitric*



Paratene™ ACI

A New Approach To Acid Corrosion Inhibitors

Introduction

Strong acids and chelating agents are used in a variety of applications, where corrosion inhibition is required, including oil well acidizing, chemical cleaning and metal pickling. In most cases the solution to be used is selected both for the ability of the cleaning solution to remove the deposit but also for the compatibility of the cleaning solutions with the materials to be cleaned.

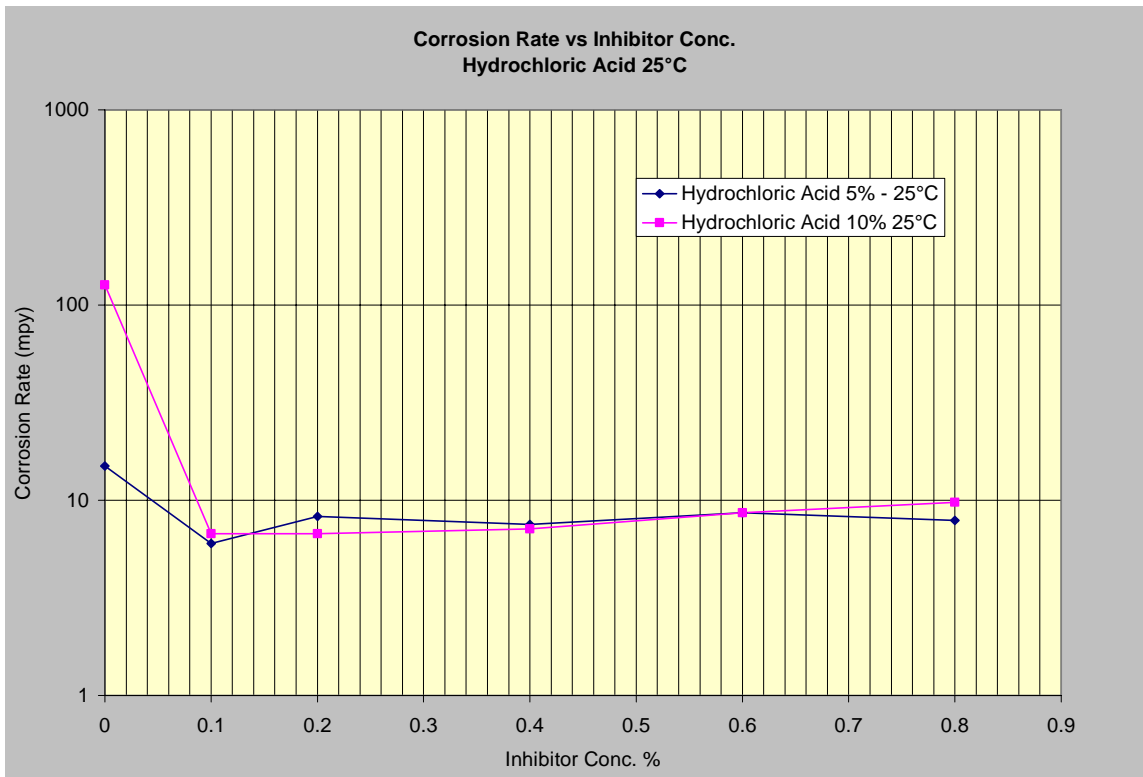
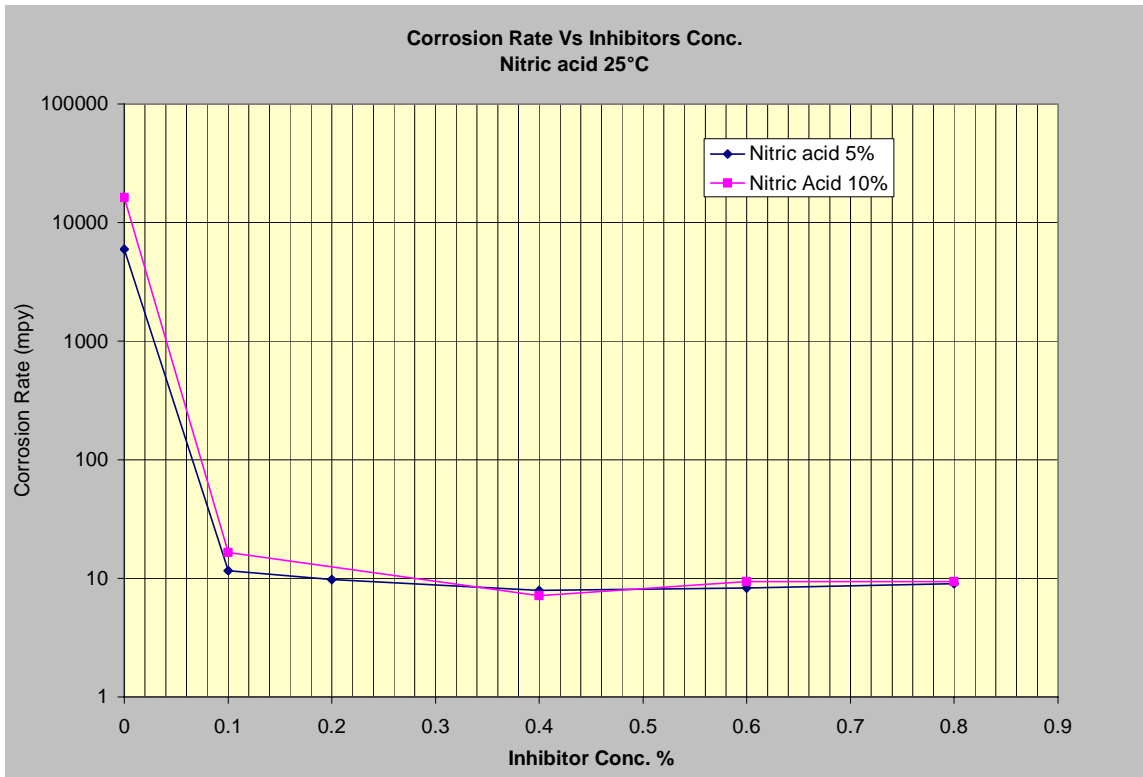
Acids (and chelants) will often corrode the base metal. To prevent the damage we apply corrosion inhibitors. A number of commercial corrosion inhibitors are available. The choice of inhibitor depends on the conditions – that is the type and concentration of the acid, the material to be cleaned, the expected contact time and the anticipated maximum temperature. Two separate groups of chemicals are typically used for corrosion inhibitors. The first, for hydrochloric, often contain a combination of unsaturated oxygen compounds, such as acetylenic alcohols, unsaturated ketones, in combination with nitrogen based materials such as quaternary or secondary amines.

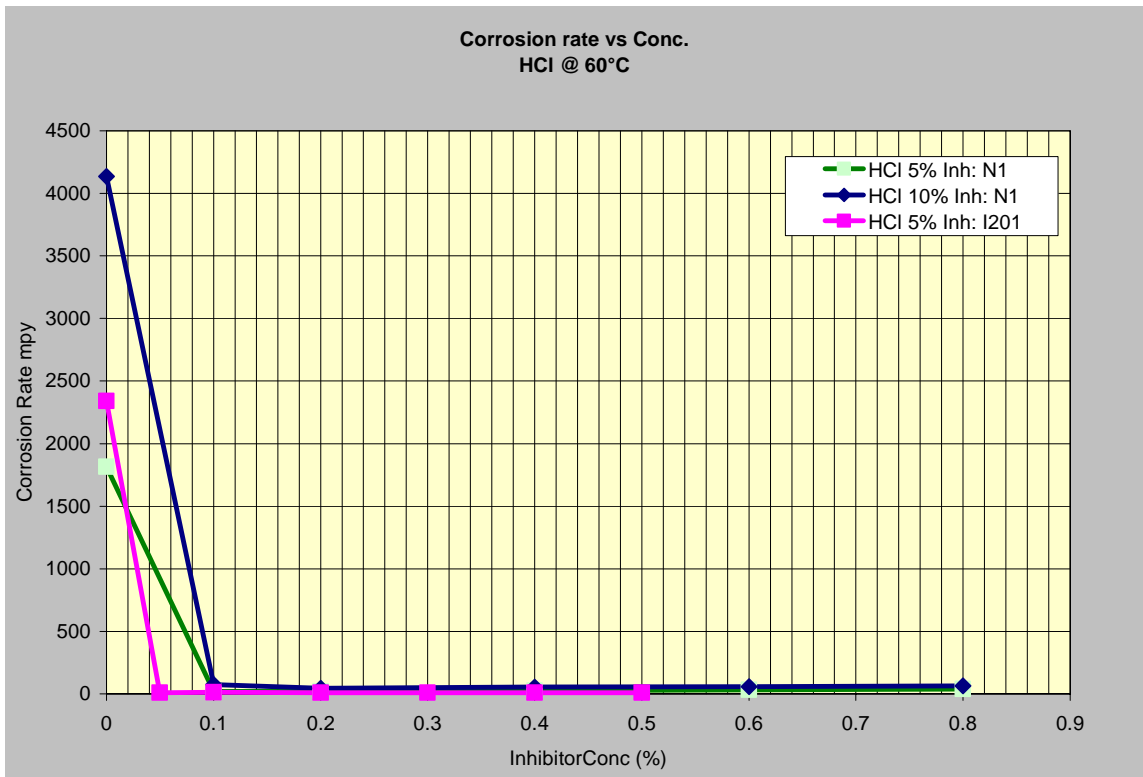
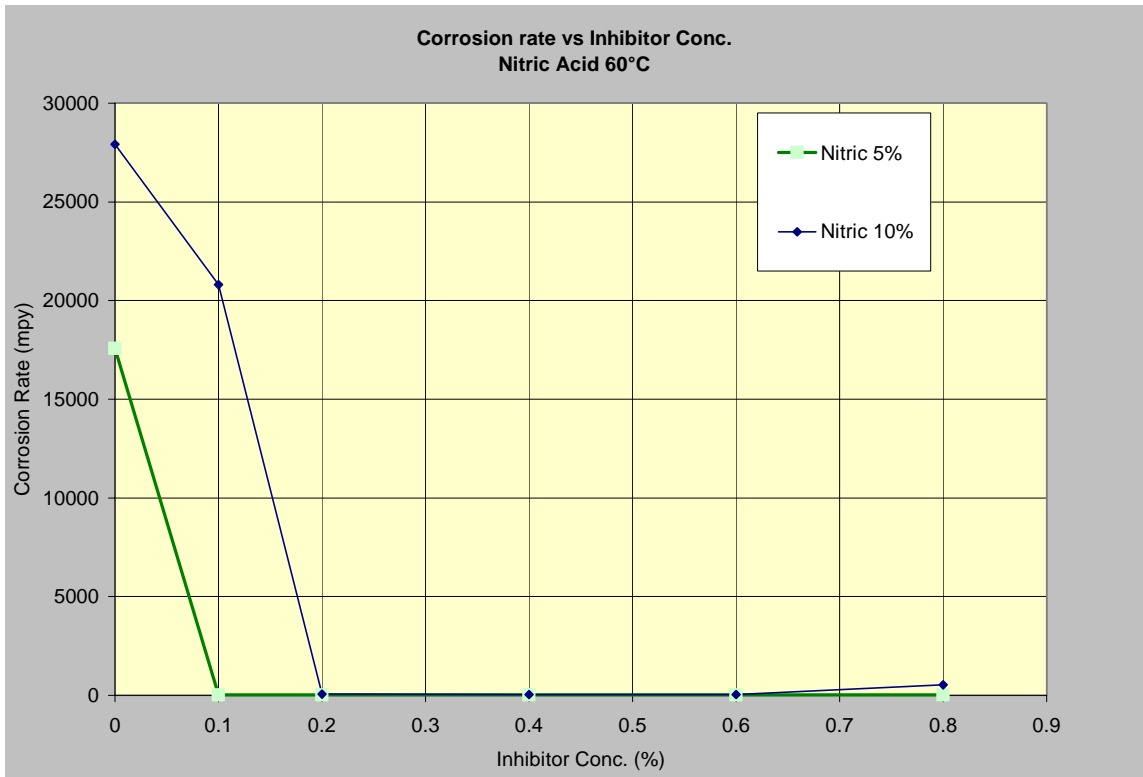
The second type or class of inhibitor is used to protect against corrosion in solutions of organic acids, chelants or sulphuric acid (but not nitric acid). These products use a reduced Sulphur compound such as thiourea or ammonium thiocyanate in combination with a nitrogen contain quaternary or secondary amine.

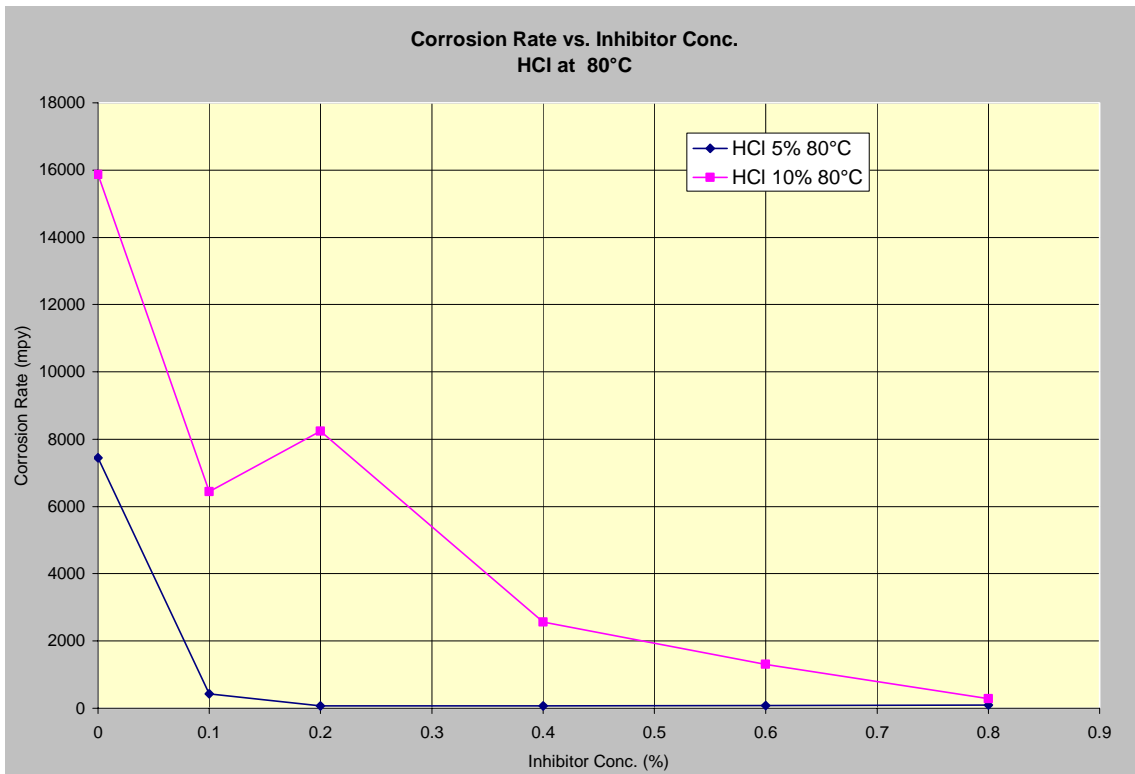
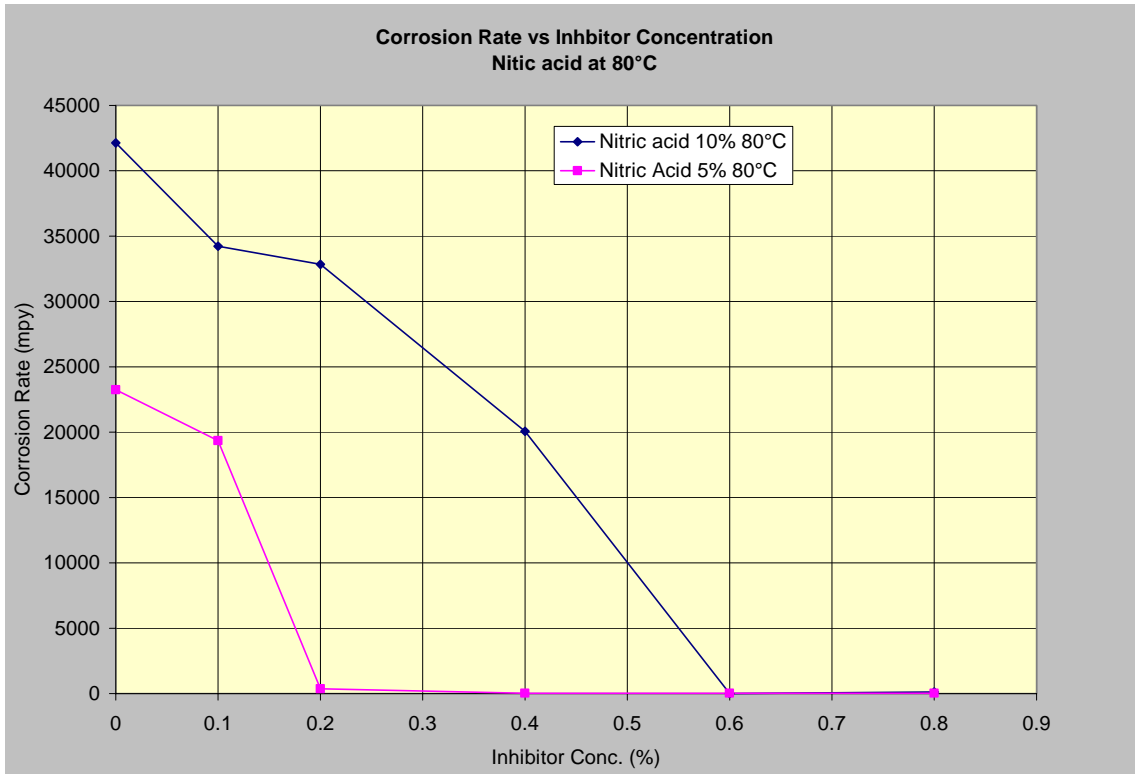
The new product Paratene™ ACI represents a major change in both the approach and the versatility of acid corrosion inhibitors. This paper will describe a new class of corrosion inhibitors that inhibits all acidic solutions including nitric acid under a wide range of conditions.

Corrosion Protection and Performance

Paratene™ ACI has been tested in a variety of acids and conditions. Based on these tests ACI can be used in dilute acids (5% or below) at temperatures up to 80°C and in stronger acids (10%) up to 60°C.







Corrosion rate and inhibitor efficiency of carbon steel using various chemical cleaning agents plus Paratene™ ACI

Cleaning Agent	Concentration		Temperature (°C)	Corrosion Rate (mm/yr.)	Inhibition %
	Agent %	ACI %			
HNO ₃	10	0.25	25	0.13	99.9
H ₂ SO ₄	10	0.25	65	0.67	99.9
H ₃ PO ₄	10	0.25	85	0.93	99.9
HCL	10	0.20	50	0.74	99.4
HF	2	0.05	60	0.69	99.4
H ₂ C ₂ O ₄	5	0.25	60	0.40	99.4
HNO ₃ -HF(8:2)	10	0.25	25	0.24	99.9
NH ₄ -citrate	3	0.05	90	0.31	99.6
CH ₃ COOH	10	0.25	85	0.52	98.9
EDTA	10	0.25	65	0.16	99.2
Sulfamic Acid	10	0.25	60	0.46	99.7
Hydroxyacetic Acid	10	0.25	85	0.38	99.4
NH ₄ -Citrate-NH ₄ HF ₂	1.8 – 0.24	0.05	90	0.39	99.3
Hydroxyacetic acid- Formic acid- NH ₄ HF ₄	2.1-0.25	0.25	90	0.74	99.2

Recommended inhibitor concentrations for Nitric and Hydrochloric acid strengths

Nitric (%wt)	Recommended ACI (%wt)	Temperature (°C)
1-5	0.2	25
6-10	0.2	25
1-5	0.2	60
6-10	0.3	60
1-5	0.3	80
6-10	Not recommended	80

Hydrochloric (%wt)	Recommended ACI (%wt)	Temperature (°C)
1-5	0.2	25
6-10	0.2	25
1-5	0.2	60
6-10	0.2	60
1-5	0.3	80
6-10	Not recommended	80

Applications for Paratene™ ACI

Paratene™ ACI opens up a wide range of possibilities for the use of acids in chemical cleaning, pickling and oil field use.

Industrial Cleaning and Metal Pickling

Nitric acid has long been avoided as a chemical cleaning acid because of its severe corrosivity and the inability to inhibit that corrosion. Nitric is the acid of choice in cleaning stainless steel, aluminium and titanium. Unfortunately, prior to the invention of Paratene ACI this required that a completely stainless steel pumping and delivery system be used, and that no alloys of steel other than stainless could be present in the system to be cleaned.

Paratene™ ACI now makes it possible to remove acid soluble deposits from stainless and mixed alloy systems without the use of an expensive stainless steel pump unit. Nitric acid can be used to remove deposits previously requiring difficult water blasting or multiple stage cleaning procedures.

Examples of this are the removal of iron sulphides and iron polysulphides from refinery and pulp and paper systems, or the cleaning of heat exchangers in amine contactors and refineries.

Oil and Gas Well Stimulation

Nitric acid has never been popular in oilfield acidizing. Its extreme corrosiveness and the inability to add a corrosion inhibition eliminated nitric acid from consideration. With the availability of Paratene™ ACI, Nitric acid can now be used as an efficient alternative for applications using strong oxidizing agents such as chlorine dioxide, sodium hypochlorite (bleach) and hydrogen peroxide.

Dilute nitric solutions can be used to clean up water injection wells which have become plugged with iron sulphide and iron polysulphides. Nitric acid solutions can be used to remove polymer blocks and plugging within subterranean geological formations. As with all acid corrosion inhibitors, pre-application testing is required to ensure the acid inhibitor is not adsorbed on the formation rock, which if it did occur would result in fluid returns with unspent and uninhibited acid.

Paratene™ ACI provides excellent corrosion protection when used within the recommended acid ranges and temperatures, and permits the use of acids such Nitric in environments formerly impossible.

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