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## **Product Comparison Files: Dee-Zol Life® vs. The Marketplace**

Bell Performance invented the first fuel additive in the year 1909 and has been formulating effective problem-solving fuel treatments ever since. In response to the market's widespread need for petroleum fuel stabilizers and anti-oxidants, Bell Performance formulated Dee-Zol Life® in 2007 as a dedicated solution for fuel users who store diesel fuel long-term for various applications. In this report, we'll compare the important functions and features of diesel fuel stabilizers and see how some of the prominent options in the marketplace compare with Dee-Zol Life®.

### **Introduction**

Today's petroleum fuels (diesel and gasoline) have a greater need for fuel stabilizers than ever before. This is due to changes in chemical makeup resulting from extensive refinery cracking and processing of these fuels. Today's stored fuels have significantly shorter storage lives – as little of 20% of what you could have expected from comparable fuels a few decades ago.

### **Diesel Fuel Stabilizers - What They're Used For**

Petroleum fuels have always been susceptible to chemical breakdown as they are exposed to environmental actors. Exposure to oxygen, water, light, heat and catalytic metals will accelerate chemical reactions involving unstable precursors that exist in the fuel from the start of its life. Left unchecked, this phenomenon will shorten the effective storage life of petroleum fuels. Unstable fuel has signature hallmarks – darkening of color, stratification of light and dark phases within the fuel, and formation of gums, resins and sludge. These hallmarks are the sign that complex polymers have formed in the fuel from unstable molecules reacting with previously-stable molecules, causing them to link together in chains of ever-increasing size. These gums and resins affect the combustion quality of the fuel, as the now-unstable fuel burns less optimally and is more likely to form problematic deposits in the engine. If the fuel's instability problem is serious enough, the fuel may not support combustion at all – a serious problem for users who store fuel to be used in critical use applications.

In response, the petroleum industry developed fuel stabilizer technologies - chemical packages that, when added to the fuel at the start of its life, would extend the effective storage life of the fuel significantly. These stabilization packages contain multiple active ingredients to address the most common pathways of the development of fuel instability – oxidation, hydrolysis, peroxide formation and catalytic metal exposure.

Professionals who work with stored fuel are well-aware of the need to treat the fuel with a stabilization package. But they may not know which fuel stabilizers fit their needs the best. They may not know which market options are better than others. They may not even know what they should be looking for when making their choice of a fuel stabilizer to use. Some fuel stabilizers are better than others when it comes to being effective in the key areas a good fuel stabilizer needs to perform in. So it may be useful to compare some of the stabilization options available in the marketplace, to see which options are the best.



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## What To Look For In A Diesel Fuel Stabilizer

The best fuel stabilizers score well on the following features listed below. Some of these features relate to active ingredients that accomplish specific functions (like dispersants), while others will imply how well the stabilizer performs (like treat rate).

### *Industry standard chemistry*

Petroleum chemists have determined that certain stabilization chemistries work better in petroleum. These may be called Phenolic (alkylated phenols) and Phenelenediamine chemistries. And there are other types of chemistries associated with some of the functionalities described below – succinimides and hydrocarbyl amines (dispersants), different esters and alkyl or aryl sulfonic acids for corrosion inhibitors (phosphoric acids would not be suitable because they would not be EPA-approved due to phosphorus content), diamines for metal deactivators, and amines or nitrogen-containing basic compounds for stabilizers. The most effective fuel stabilizers should have their chemistries fall under one or more of these industry standards.

### *Anti-Oxidant Ingredient(s)*

Perhaps the biggest mode of fuel instability is oxidation, in which oxygen (likely from small amounts of air dissolved in the fuel) attacks reactive compounds in the fuel. This sets off complex chemical chain reactions that form gums and sediment that destroy fuel quality. These gums and sediments also block filters and leave performance-robbing deposits on fuel injector nozzles. Today's diesel fuels are more prone to these oxidation problems because they contain more cracked stocks, more olefinic (unstable double-bonded molecules) and more nitrogen compounds. The most effective fuel stabilizers will contain anti-oxidants that work by interrupting these chain reactions to stop them from progressing.

### *Acid-Base Stabilizer Ingredient(s)*

Acid-base reactions are another key element of fuel instability. The most effective fuel stabilizer formulations will contain ingredients to prevent these reactions. These typically are strongly basic amine (NH) chemistries. They work by reacting with weakly acidic compounds in the fuel to form by-products that remain dissolved in the fuel, but do not react further. This helps the prevention of sediment formation in the stored fuel.

### *Dispersant Ingredient(s)*

A dispersant doesn't prevent fuel instability reactions, but works to disperse the particulates that form over time. Dispersants are essential elements of effective fuel stabilizers, as they prevent these particulates from clustering into aggregates large enough to plug fuel filters or injectors.

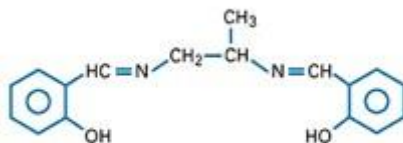
### *Corrosion Inhibitor Ingredient(s)*

Since most petroleum pipes and tanks are made of steel, it is common to have corrosion problems like the formation of rust in the presence of water. Over time, severe rusting can eat holes in steel walls, creating leaks. More specific to the fuel stability issue, the fuel may become contaminated by these rust particles, which can plug fuel filters and increase fuel pump and injector wear. The best fuel stabilization packages will have corrosion inhibitor components that attach to metal surfaces and form a protective barrier to prevent attack by corrosive agents.

### *Metal Deactivator Ingredient(s)*

When trace amounts of certain metal ions, especially copper and iron, are dissolved in diesel fuel, they catalyze (accelerate) the reactions involved in fuel instability. Research shows that these metals, by their presence, shorten the storage life of both petro-diesel and biodiesel fuels. Metal deactivators tie up (chelate) these metals, Neutra™izing their catalytic effect. The best fuel stabilizer packages will contain metal deactivation ingredients and will use them in conjunction with anti-oxidants to prevent the catalysis of oxidation reactions.

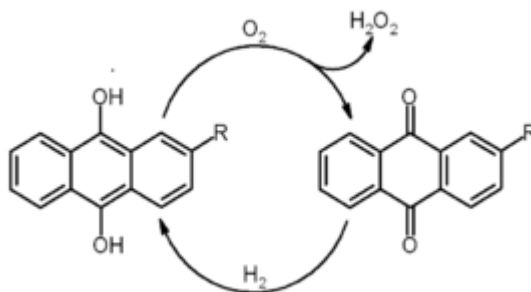
#### Metal Deactivator



*N, N-Disalicylidene-1, 2-propanediamine (DMD)*

### *Anti-Peroxidal*

Peroxides are a class of reactive molecules that are associated with the process of fuel instability. Stored fuel may have a tendency to form peroxide compounds, especially when exposed to some of the environmental bad actors referenced before. They are not as much of a problem in low-sulfur diesel fuels, but ultra-low sulfur diesel fuels are another story – the higher levels of hydro-processing make ULSD fuels more prone to peroxide formation. Peroxide formation is also an especially serious problem in diesel fuels with low level biodiesel content. Peroxides form over time at higher temperatures and are associated with degradation of polymer components in fuel pumps and fuel systems if they build up in concentrations exceeding 8 ppm. A good fuel stabilizer will contain ingredients that effectively Neutra™ize the formation of peroxides in treated fuel.



### *Low treat rate*

Treat rate matters in two respects. First, it determines the cost to use. Fuel stabilizers are used by B2B users who all happen to be cost-conscious. It would not be viable to have a fuel stabilizer that is expensive to use. The cost needs to be kept down so it does not add excessively to their overhead. A stabilizer requiring a 1:500 (1 ounce to 4 gallons) treat rate is going to be 6x (six times) as expensive to use as another stabilizer with a treat rate approaching 1:3000 (1 ounce to 25 gallons).

Second, treat rate gives a window in on how effective you might expect the given product to be. Since you



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need a minimum amount of the different kinds of active ingredients delivered into the fuel, an effective fuel stabilizer cannot have a treat rate that is excessively low. While it is theoretically possible for a stabilization package to have some amount of all of the recommended active ingredients at a treat rate as low as, say, 1 ounce to 80 gallons (1:10000), it's not likely to be as effective as it might claim to be. Conversely, a high quality fuel stabilizer that does everything you need it to shouldn't require you to use a lot of it. But you do have to use enough to ensure the optimal amount of active ingredients make it into the fuel. Ideally, a good fuel stabilizer should have a treat rate between 1:1000 (1 ounce to 8 gallons of fuel) and 1:4000 (1 ounce to 30 gallons of fuel).

### ***EPA-Registered***

By law, all on-road fuel additives must be registered with the Fuel Additives division of the United States EPA. This includes re-labels and re-names of existing additives (of which, there are many). There's no requirement to put a registration statement on the product label, so you may not be able to tell just by looking at that if the diesel fuel additive is EPA-registered. The full list of registered fuel additives, whether gasoline or diesel, can be found simply by googling "EPA list of registered fuel additives". If an on-road fuel additive is not EPA-registered, it's not legal to sell it in the United States.

That's to say nothing of whether the additive will actually work or not. An additive maker that hasn't taken the time to comply with the simple additive registration process (it's free) is not likely to be taking the time to formulate an additive that really works, whatever the additive's claims may be. It is also important to keep in mind that EPA-registration does not mean that the EPA or the United States government is endorsing an additive, or even that it works. EPA-registration is concerned with the contents of the formulation from a safety standpoint. They do not care what claims of greatness are made about it.

## **Dee-Zol Life® vs. The Marketplace Competition**

Now that we have a clearer picture of the hallmarks of a good diesel fuel stabilizer vs. a not-so-good one, let's see how Dee-Zol Life® from Bell Performance compares to some of the most popular diesel stabilizer additive names in the marketplace. The comparison formulations were selected based on consumer familiarity and market penetration of the brand names. There are many others that could have been included in the comparison, but space limitations prevail.

Of the myriad of diesel fuel stabilizers out there, these are some of the more well-known selections.

The logo for STA-BIL, featuring the word "STA-BIL" in a large, bold, red, italicized sans-serif font.

***Diesel Formula Sta-Bil® Fuel Stabilizer*** (Gold Eagle) - Gold Eagle's Diesel Formula Sta-Bil® Fuel Stabilizer formulation is very well-known within the industry as a fuel stabilizer for diesel fuel. In fact, the name Sta-Bil® is associated by many consumers as synonymous with "fuel stabilizer". The Gold Eagle company was started in 1932 and has significant market presence in the automotive aftermarket arena. They have a broad range of products including HEET for gasoline, ethanol fuel treatment, starter fluid, washer fluid deicer and octane improvers (technically not street-legal). For the purposes for this comparison, Dee-Zol Life® will be compared with Gold Eagle's Diesel Formula Sta-Bil® Fuel Stabilizer.



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**K100®-MD** (Kinetic Laboratories) – Kinetic Laboratories was founded as Reaction Laboratories in Buffalo, NY in the early 1960s. Initially, they ran as a small chemical company that provided boiler water treatment products for local industry in Western New York. The company later created the K-100D formula as a multifunction treatment for heavy fuel oil. Later, the company branched out with similar formulations for gasoline and light diesel fuels. For this comparison, Dee-Zol Life® will be compared to the K100®-MD formulation for diesel fuel.



**PRI-D®** (Power Research, Inc.) – The Power Research company was founded in Houston in 1985. The backbone of its initial business was a proprietary fuel chemistry for heavy marine fuels, along with a synthetic lubricity additive technology. For most of its history, Power Research has focused on heavy marine shipping fuels, although they did launch a consumer division in 1989. Today, Power Research supplies fuel additives to both market sectors under its PRI product family brand. For this comparison, Dee-Zol Life® will be compared to the PRI-D® formulation for diesel fuel.








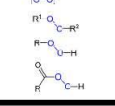

**Schaeffer 192<sup>ND</sup> Neutra™ Plus Diesel Fuel Stabilizer** (Schaeffer Oil) – Schaeffer (or Schaeffer's) is one of the more well-known names in the petroleum industry. It's certainly one of the oldest, founded as Schaeffer Manufacturing Co. by Nicholas Schaeffer in 1839. As their primary business was lubricant products, this makes Schaeffer the longest running lubricant manufacturer in the United States. Nicholas Schaeffer was actually the first millionaire in the city of St. Louis, even before Eberhard Anheuser (founder of the Anheuser-Busch brewing empire). The Schaeffer company has weathered many storms over the years (including financial ruin in the economic panic of 1875). Today, Schaeffer Oil's product line extends far beyond simple lubricants, though they do offer engine oil, gear oil, industrial oil and greases. Schaeffer also deals in transmission and hydraulic fluids, surfactants, soil conditioners and, of course, fuel additives. For this comparison, Dee-Zol Life® will be compared to Schaeffer's 192ND Neutra™ Plus Diesel Fuel Stabilizer.

## Comparative Infographic – Dee-Zol Life® vs. The Marketplace

The infographic below summarizes the features and claims made by each stabilizer additive. This is followed by a summary description of how each type of diesel stabilizer performs in each desired area. The goal is to provide a clearer picture of the features and effectiveness of each formulation vs. its actual product claims.

## Fuel Stabilizers are essential for stored fuel health. Which one is right for you?

When it comes to stability improvers for diesel fuel, there are lots of choices.  
Here's how some of the best-known choices compare.

DIESEL FUEL STABILIZERS		DEE-ZOL LIFE®	DIESEL FORMULA STA-BIL® FUEL STABILIZER	K-100MD®	PRI-D®	SCHAEFFER® 192ND NEUTRA PLUS
	Anti-oxidant	✓	✓	✓	✓	✓
	Acid-base stabilizer	✓	✓			
	Dispersant	✓	✓	✓	✓	✓
	Corrosion inhibitor	✓	✓			
	Metal deactivator	✓				
	Anti-peroxidal	✓				✓
	Low treat rate	✓			✓	
		1 oz per 16 gal	1 oz per 10 gal	1 oz per 8 gal	1 oz per 16 gal	1 oz per 1.5 gal

✓ = Good Choice

**The choice is clear.**

Dee-zol Life® from Bell Performance does more - for less - than any of these other popular diesel fuel stabilizers. Dee-Zol Life® is the right choice when you need a diesel fuel stabilizer.





How do these diesel fuel stabilizers compare with respect to their functionality and components?

**Anti-oxidant** – All five formulations contain anti-oxidant components. This is not surprising, as one could not claim to be a fuel stabilizer without, at least, having this component.

Anti-Oxidant Component		
<b>Dee-Zol Life®</b>	Contains anti-oxidant component to slow formation of gums and sludge	
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	Contains anti-oxidant component to slow formation of gums and sludge	
<b>K100®-MD</b>	Contains anti-oxidant component to slow formation of gums and sludge	
<b>PRI-D</b>	Contains anti-oxidant component to slow formation of gums and sludge	
<b>Schaeffer 192ND Neutra™ Plus</b>	Contains anti-oxidant component to slow formation of gums and sludge	

**Acid-Base Stabilizer** – Only two of the formulation – Dee-Zol Life® and Sta-Bil® – showed evidence of their formulations containing components needed to accomplish neutralization of acidic components. PRI-D, K100®-MD and Schaeffer 192ND Neutra™ Plus gave no such indication they can do this.

Acid-Base Stabilizer		
<b>Dee-Zol Life®</b>	Contains ingredients to neutralize acidic components	
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	Contains ingredients to neutralize acidic components	
Does Not Contain Acid-Base Stabilizer		
<b>PRI-D</b>	No clear evidence that it contains ingredients to neutralize acidic components	
<b>K100®-MD</b>	No clear evidence that it contains ingredients to neutralize acidic components	
<b>Schaeffer 192ND Neutra™ Plus</b>	No clear evidence that it contains ingredients to neutralize acidic components	



**Dispersant** – As with anti-oxidant components, all five formulations contain dispersant ingredients to prevent particulates from forming larger aggregates.

Dispersant Component		
<b>Dee-Zol Life®</b>	Contains dispersant ingredients to slow formation of larger sludge molecules	
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	Contains dispersant ingredients to slow formation of larger sludge molecules	
<b>K100®-MD</b>	Contains dispersant ingredients to slow formation of larger sludge molecules	
<b>PRI-D</b>	Contains dispersant ingredients to slow formation of larger sludge molecules	
<b>Schaeffer 192ND Neutra™ Plus</b>	Contains dispersant ingredients to slow formation of larger sludge molecules	

**Corrosion Inhibitor** – Only two of the five formulations – Dee-Zol Life® and Sta-Bil® – give indications that they contain ingredients to retard corrosion phenomenon on metal surfaces. PRI-D, K100®-MD and Schaeffer 192ND Neutra™ Plus do not show evidence that they actually contain anything that accomplishes this function, despite some of their claims.

Corrosion Inhibitor		
<b>Dee-Zol Life®</b>	Contains ingredients to protect against corrosion	
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	Contains ingredients protect against corrosion	
Does Not Contain Corrosion Inhibitor		
<b>PRI-D</b>	No clear evidence that it contains ingredients to protect against corrosion	
<b>K100®-MD</b>	No clear evidence that it contains ingredients to protect against corrosion	
<b>Schaeffer 192ND Neutra™ Plus</b>	Makes a claim of corrosion inhibition, but no indication from its SDS that it contains ingredients associated with accomplishing this	





**Metal Deactivator** – Even more clear than corrosion inhibition or acid-base stabilization, only one of the formulations – Dee-Zol Life® – contains specific ingredients to prevent accelerated degradation of fuels exposed to catalytic metals over the course of their life. The other four formulations show no evidence of containing any relevant ingredients to accomplish this function, which normally is considered an important element of effective fuel stabilization over the course of its extended life.

<b>Metal Deactivator</b>		
<b>Dee-Zol Life®</b>	Stabilization package contains specific ingredients to target and neutralize the catalytic effects of exposure to problematic metals	
<b>Does Not Contain Meta Deactivator</b>		
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	No clear evidence that it contains ingredients to neutralize catalytic metal exposure	
<b>PRI-D</b>	No clear evidence that it contains ingredients to neutralize catalytic metal exposure	
<b>K100®-MD</b>	No clear evidence that it contains ingredients to neutralize catalytic metal exposure	
<b>Schaeffer 192ND Neutra™ Plus</b>	No clear evidence that it contains ingredients to neutralize catalytic metal exposure	

**Anti-Peroxidal** – Only two of the five formulations – Dee-Zol Life® and Schaeffer 192ND Neutra™ Plus – contain these essential components. The other three formulations neither show such evidence or make claims to contain such ingredients.

<b>Anti-Peroxidal Ingredients</b>		
<b>Dee-Zol Life®</b>	Contains ingredients to neutralize peroxide formations	
<b>Schaeffer 192ND Neutra™ Plus</b>	Contains a cresol derivative used as a stabilizer and as a peroxide neutralizer	
<b>Does Not Contain Anti-Peroxidal</b>		
<b>PRI-D</b>	No clear evidence that it contains ingredients to neutralize peroxide molecules	
<b>K100®-MD</b>	No clear evidence that it contains ingredients to neutralize peroxide molecules	
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	No clear evidence that it contains ingredients to neutralize peroxide molecules	



## Comparisons of Treat Rate Relative To Claimed Benefits

The other side of the coin, no pun intended, is the cost of use for any fuel stabilizer. And cost of use is determined by treat ratio. If we examine typical retail pricing for these diesel fuel stabilizers, we can see some difference in how much they cost to use, relative to the essential functions and features they actually possess. We can also see how these compare with their essential functions relative to their retail pricing cost of use (calculated as cost to treat 100 gallons of stored diesel fuel).

To summarize the findings, we've listed all five formulations compared, their total number of benefits, and the claimed treat rates recommended to achieve those benefits.

Stabilizer Product	# of Benefits	Benefits Claimed	Treat Rate
<b>Dee-Zol Life®</b>	8	Anti-oxidant, Acid-base stabilizer, Dispersant, Corrosion inhibitor, Metal deactivator, Anti-peroxidal, Low treat rate, Low cost to use	1 oz: 16 gallons (1:2000)
<b>Diesel Formula Sta-Bil® Fuel Stabilizer</b>	4	Anti-oxidant, Acid-base stabilizer, Dispersant, Corrosion inhibitor	1 oz: 10 gallons (1:1280)
<b>K100®-MD</b>	2	Anti-oxidant, Dispersant	1 oz: 8 gallons (1:1000)
<b>PRI-D</b>	4	Anti-oxidant, Dispersant, Low treat rate, Low cost to use	1 oz: 16 gallons (1:2000)
<b>Schaeffer 192ND Neutra™ Plus</b>	3	Anti-oxidant, Dispersant, Anti-peroxidal	1 oz: 1.5 gallons (1:200)



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## Conclusions

Those who store diesel fuel know they must treat the fuel with a good stabilizer or risk the viability of their investment. They have many choices in the marketplace and it may be difficult for them to see meaningful distinctions between those choices.

A more rigorous examination of stabilizer candidates leads us to conclude the following, listing our conclusions by product in the order of best to worst choice, by our assessment.

The final winner of the comparison will be listed last:

- **Diesel Formula Sta-Bil® Fuel Stabilizer** provided the second best combination of features relative to cost. It shows evidence of four essential functions (anti-oxidant, acid-base stabilization, dispersant, corrosion inhibitor).
- **PRI-D** only provided two essential stabilizing functions – anti-oxidation protection and dispersant ability. It does also provide lubricity as a value-added feature. On the bright side, PRI-D had the lowest treat rate (tied with Dee-Zol Life®).
- **K100®-MD** found itself in the same boat as PRI-D in providing only two essential stabilizing functions (anti-oxidant and dispersant). Unfortunately, K100®-MD's treat rate was twice as high.

The least recommended stabilizer formulation was:

- **Schaeffer 192ND Neutra™ Plus** brings up the rear of the list for least recommended stabilizer. It did provide anti-peroxidal protection, which differentiates itself from PRI-D and K100®-MD. So it had an advantage of providing one additional benefit compared to those two competitors. Unfortunately for the Schaeffer stabilizer, its treat rate was extremely high – 1:200. This results in the cost to use being significantly higher than most other stabilizer choices in the market. For this reason, the Schaeffer® stabilizer ranks as the bottom stabilizer in the comparison.

And finally, after analyzing all essential functionality in conjunction with cost-to-use, we conclude that Dee-Zol Life® wins the comparison.

- **Dee-Zol Life®** is the only stabilizer formulation in this comparison that provides the complete spectrum of recommended functionality for effective stabilization of diesel fuel. The closest competitor to Dee-Zol Life® in this respect was the Sta-Bil® formula – however, Dee-Zol Life® contains metal deactivators and anti-peroxidal components that the Sta-Bil® product did not. Dee-Zol Life® provided the highest level of functionality of all the stabilizers compared.