Field Demonstration For P-D-680 Solvent Replacement

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### Field Demonstration for P-D-680 Solvent Replacement

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**ABSTRACT (Maximum 200 words)**

As part of the second phase in development of environmentally compliant solvent alternatives to P-D-680, field demonstrations were initiated at Ft. Lewis WA, Ft. Hood TX, and Kelly Air Force Base. The main objectives of this demonstration were to validate performance of candidate solvents with existing military equipment and to determine the environmental acceptability for these candidate solvents. Four (4) petroleum-based solvents and four (4) terpene/hydrocarbon blended solvents have been selected as candidates for these field demonstrations. Ft. Lewis was designated as a major field testing site and evaluated eight (8) candidate solvents in various military ground equipment, helicopter, and weapon cleaning application. Ft. Hood evaluated two (2) different types of candidate solvents using the IT-48 weapons cleaning system in helicopter maintenance applications. San Antonio Air Logistic Center at Kelly AFB evaluated three (3) candidate solvents using existing part washers for aviation applications. Field test results showed that both severe hydrotreated odorless hydrocarbon solvents and hydrotreated terpene/hydrocarbon blended solvents were well accepted in all applications. Six candidate solvents were rated by users as acceptable replacements for P-D-680.

**SUBJECT TERMS**
P-D-680, Solvent, Alternative Solvents, Solvency, Field demonstration, Aviation, Ground equipment, Petroleum hydrocarbon, Terpene
Acknowledgments

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The author wishes to thank the all local testing coordinators and participating organizations who actually evaluated candidate solvents. Also, the author wishes to thank solvent industries who provided candidate solvents for these field demonstrations.
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Section 1  Background

Department of Defense (DOD) facilities have been and continue to experience problems using P-D-680, Dry Cleaning and Degreasing Solvent\textsuperscript{1}, for their maintenance activities. Currently, numerous federal, state, and local regulations limit usage of P-D-680 as it is considered a hazardous waste, a flammable material, and a toxic substance\textsuperscript{2}. To resolve this problem, the Fuels and Lubricants Technology Team of the Mobility Technology Center - Belvoir (MTC-B) as the specification Preparing Activity for P-D-680 has been working to develop environmentally compliant solvent alternatives that meet military requirements. This program, resourced under the Defense Supply Center Richmond’s HAZMIN Program, was divided into the following two Phases.

**Phase I:** Conduct user survey for P-D-680 solvents and evaluate commercial alternative solvents

**Phase II:** Conduct field validation tests, and revise the P-D-680 specification

During 1994-1995, a P-D-680 user survey was completed to determine requirements and constraints for general purpose cleaning solvents to meet military needs. Based on the user survey, a new vision was established to resolve current P-D-680 problems and evaluate commercial candidate solvents as P-D-680 replacements. As a follow-up action, eighty-two (82) solvent samples were evaluated and comparisons made to P-D-680 solvents. It was found only petroleum distillate hydrocarbon solvents and terpene/hydrocarbon solvents met the current P-D-680 performance needs. Especially, terpene/hydrocarbon blended solvents gave excellent performance in all aspects of the laboratory testing requirements. Aqueous types of solvents and water based solvents were not applicable due to both their poor corrosion protection and solvency. Based on these test results, twenty-three (23) commercial solvents were selected as potential candidate alternative P-D-680 solvents. The test results were summarized in a TARDEC technical report\textsuperscript{3} entitled “Replacement of P-D-680 Solvents for General Maintenance of DOD Equipment”.

In concert with the Phase II portion of this initiatives, field demonstrations were initiated in 1996 at Army and Air Force installations to verify performance and environmental applicability of candidate solvents under a variety of field environments. Ft. Lewis WA was designated as a major field testing site for this demonstration and evaluated eight (8) candidate solvents in various military ground equipment (e.g., tactical vehicles), helicopter, and weapon cleaning applications. Ft. Hood evaluated two (2) different types of candidate solvents in helicopter maintenance applications.
For Air Force applications, San Antonio Air Logistic Center at Kelly AFB TX evaluated four (4) candidate solvents using aviation equipment and ground support equipment. The field demonstrations have been completed and data analyzed for each participating location.

This interim report summarizes the results of field demonstrations and findings.
Section 2  Field Demonstration Program

(a) Objective:

The main objectives of this field testing were (1) to verify performance (i.e., solvency, cleaning ability, compatibility) of candidate solvents in existing military equipment and, (2) to determine the environmental assessment for these candidate solvents (i.e., local/federal environmental laws, user safety). The successful completion of this demonstration would result the current P-D-680 solvents being replaced with environmentally friendly products.

(b) Scope:

The field demonstration encompassed three sites, Ft. Lewis WA, Ft. Hood TX and Kelly Air Force Base TX and focused on solvent cleaning performance and potential environmentally acceptability of candidate alternative P-D-680 solvents. Four (4) petroleum based solvents and four (4) terpene/hydrocarbon based solvents were finally selected as candidates for these cooperative field validation. The field validation of candidate solvents was performed using a wide variety of military equipment including weapon systems and measured by comparing their performance against provided by current P-D-680 solvents. The duration of this field test was designed for a three month evaluation period. The final acceptance of the candidate solvents would be based on the field testing evaluation and resultant findings generated.

(c) Field Testing Solvents:

The eight (8) solvents identified in Table 1 were selected from the twenty-three (23) candidate solvents recommended from Phase I. Three (3) petroleum based solvents were designated as P-D-680 Type II solvents and had different types of odor characteristics (i.e., odorless, milder, strong). An odorless petroleum based candidate solvent designated as a Type III was selected in order to make a comparison with the P-D-680 Type III solvent. Four (4) terpene/hydrocarbon blended solvents were also selected as a new proposed Type IV solvent under P-D-680. The laboratory test results are shown in Table 2 for these solvents along with the P-D-680 solvents. Also, the test methods used in this laboratory evaluation and the P-D-680 specification requirements are provided in Appendix A.
Table 1: Field Demonstration Solvents

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Designated P-D-680 Type</th>
<th>Odor Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakthrough</td>
<td>I</td>
<td>Odorless</td>
</tr>
<tr>
<td>Actrel 1171L</td>
<td>II</td>
<td>Strong hydrocarbon odor</td>
</tr>
<tr>
<td>Unocal 150</td>
<td>II</td>
<td>Mild hydrocarbon odor</td>
</tr>
<tr>
<td>134 Hi-Solv</td>
<td>III</td>
<td>Odorless</td>
</tr>
<tr>
<td>Skysol</td>
<td>IV</td>
<td>Citrus</td>
</tr>
<tr>
<td>Skysol 100</td>
<td>IV</td>
<td>Citrus</td>
</tr>
<tr>
<td>Electron 296</td>
<td>IV</td>
<td>Citrus</td>
</tr>
<tr>
<td>PF</td>
<td>IV</td>
<td>Citrus</td>
</tr>
</tbody>
</table>

* Proposed new P-D-680 Solvent Type

(d) Field Testing Sites and Procedure:

Tables 3-5 summarize field testing sites and solvents that were evaluated at each installation as well as identifying the cleaning procedure used and equipment. All maintenance shops listed in these Tables currently use the P-D-680 Types I and II solvents in various types of part washers. To identify the field sites, special codes were used through this field demonstration; namely, FLT is Ft. Lewis, FHT is Ft. Hood, KAT is Kelly Air Force Base.

- Ft. Lewis, WA as previously stated was designated a major field testing site and evaluated all eight (8) candidate solvents in various military ground equipment (i.e., tactical vehicles) and helicopters in ten (10) different types of maintenance shops. Thirteen (13) IT-30 part washers procured by the Public Works Environmental and Natural Resources Division at Ft. Lewis were used in this solvent evaluation program. Additionally, three (3) candidate solvents designated as the proposed Type IV were evaluated at six (6) weapon cleaning stations.

- Ft. Hood, TX evaluated two (2) different types of candidate solvents using IT-48 weapons cleaning system (i.e., part washer) in helicopter application. Four (4) different maintenance shops participated in this field demonstration.

- San Antonio Air Logistic Center at Kelly AFB, TX evaluated four (4) candidate solvents using existing part washers in aviation applications.
(e) Schedule:

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ft. Lewis equipment installation &amp; testing set up and coordination</td>
<td>13-14 May 1996</td>
</tr>
<tr>
<td>Ft. Hood equipment installation &amp; testing set up and coordination</td>
<td>20-21 May 1996</td>
</tr>
<tr>
<td>San Antonio Air Logistic Center (ALC) testing set up and coordination</td>
<td>22 May 1996</td>
</tr>
<tr>
<td>Field Test Initiation</td>
<td>1 June 1996</td>
</tr>
<tr>
<td>In Progress Review at Ft. Lewis</td>
<td>30 July 1996</td>
</tr>
<tr>
<td>In Progress Review at Ft. Hood</td>
<td>1 August 1996</td>
</tr>
<tr>
<td>In Progress Review at San Antonio ALC</td>
<td>2 August 1996</td>
</tr>
<tr>
<td>Field Test Completed</td>
<td>31 August 1996</td>
</tr>
</tbody>
</table>

(f) Data Collection:

All testing results and operator/user comments were recorded and tabulated using the attached Solvent Evaluation Sheet (Appendix B). Data have been reviewed and collected on a bi-weekly basis. The following performance characteristics were closely monitored at each testing site:

- The cleaning/soil removal performance of candidate solvents were compared to existing P-D-680 solvents (e.g., takes longer, requires more solvents, leave residue, does not remove soil, etc.)

- Any material incompatibility was identified (e.g., softens plastics, elastomers, etc).

- Corrosion protection characteristics were evaluated (e.g., evidence of pitting, rust, discoloration, etc).

- Drying time was noted (i.e., solvent remains or evaporates, air-blow required, etc).

- Environmental assessment were determined (i.e., health and safety factors, operator acceptability, odor, etc).
(g) Data Evaluation Score System:

To effectively evaluate field data, a score system was developed based on a typical university grading system. Maximum score was designated as 100 points and divided evenly between solvent performance and environmental assessment. The acceptance criteria for the candidate solvents was established at a rating of 80 points or higher using the following Data Evaluation Score System.

**Solvent Performance**

<table>
<thead>
<tr>
<th></th>
<th>50 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>(unacceptable to acceptable ranges)</td>
<td></td>
</tr>
</tbody>
</table>

- Solvent Cleaning Power (i.e., excellent=15 points, poor=3 points) 3-15
- Compatibility (i.e., Yes=zero, No=10 points) 0 to 10
- Drying time (i.e., fast=5 points, slow=1 point) 1-5
- Corrosion (i.e., Yes=zero, No=10 points) 0 to 10
- Residue (i.e., Yes=zero, No=10 points) 0 to 10

**Environmental Assessment**

<table>
<thead>
<tr>
<th></th>
<th>50 points</th>
</tr>
</thead>
</table>

- Odor Characteristics (i.e., strong=5, milder=20, odorless=25) 5-25
- Toxicity (i.e., severe=5, less=20, no=25) 5-25

The degree of toxicity was measured based on worker skin irritation. It was divided into three categories and defined as follows:

- **No toxicity**: Solvent does not adversely affect user's skin irritation without wearing rubber gloves
- **Less toxicity**: Solvent does not adversely affect user's skin irritation with wearing rubber gloves.
- **Severe toxicity**: Solvent does adversely affect user's skin irritation with wearing rubber gloves.
Overall Rating System

90 - 100  excellent
80 - 89  good
70 - 79  average
0 - 69  poor

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Section 3  Test Results

A summary of the field test results and user's comments is presented in Tables 6-8. To analyze the data, each solvent was evaluated separately using the above described solvent cleaning performance and environmental assessment criteria, and the comments were converted to numerical system using the data evaluation score method. The final rating was derived based on the results of these field evaluations. The typical raw data sheets gathered from the field tests are provided in Appendix C. Data obtained for each candidate solvent were generated from three main military applications (i.e., ground equipment, aviation equipment, weapon system) at three different military installations. The cleaning methods used in this demonstration were the routine maintenance part cleaning procedures using IT-30/48 part washers and the other types of part washers such as a potable part cleaner. To validate the field data, most candidate solvents were tested at two different testing sites in each installation except for Kelly Air Force Base. Ft. Lewis evaluated eight (8) candidate solvents at eighteen (18) testing sites in three different applications; tactical vehicles, helicopters, small arms. Fort Hood also evaluated two (2) different types of candidate solvents at four (4) aviation maintenance shops. San Antonio Air Logistic Center at Kelly AFB assessed three (3) candidate solvents at two aviation repair shops. Representative photographs taken from the testing sites are provided in Appendix D.

For practical purposes, the field demonstration focused on solvency, drying time, compatibility, corrosion protection, residue, odor, and toxicity of candidate solvents. To draw the baseline of field performance, the P-D-680 Type II solvent was reevaluated concurrently. This solvent was originally formulated with petroleum distilled hydrocarbon and used for dry cleaning, spot, and stain removing, and for degreasing of component parts in maintenance activities. Most participants are currently using this solvent as a primary cleaning agent in their maintenance activity and have reported that P-D-680 Type II solvent to be an excellent degreaser with good corrosion protection properties, but has an offensive odor and some toxicity. Because of these environmental deficiencies, P-D-680 Type II was defined as environmentally unfriendly solvent and rated as a "poor solvent".

In ground equipment applications, three candidate solvents (Breakthrough, Unocal 150, Actrel 1171L) designated as Type II were tested in Ft Lewis tactical vehicle maintenance shops and compared with P-D-680. All three solvents were somewhat hydrotreated in order to reduce toxic aromatic materials such as benzene that provides a strong solvency. The test results showed although the new solvents provided somewhat weaker solvency than P-D-680, they demonstrated good cleaning ability in a wide variety of soils, especially heavily contaminated grease, hydraulic
fluid, engine oils, tar, carbon deposits and waxes. A candidate solvent (134 Hi-Solv) for Type III was also tested in tactical vehicle applications. Most users reported the performance of this solvent to be equivalent to the P-D-680 Type III. To determine suitability of terpene/hydrocarbon blended solvents in P-D-680 applications, three candidate solvents (Skysol 100, PF, Electron 296) were evaluated using tactical vehicle’s parts such as wheel bearing, hydraulic fluid pump, engines, etc. These candidate solvents are actually hydrocarbon solvents containing small amounts of de-limon material (>15%) which used to enhance solvency. These candidate solvents were proposed as the to-be-established P-D-680 Type IV solvent. However, most users reported the solvency of the terpene/hydrocarbon blended solvents was the same as the other types of candidate hydrocarbon solvents. All solvents tested in ground equipment provided adequate solvent power which correlated with the laboratory evaluations. No corrosion, residue and compatibility problems were reported. Two hydrocarbon solvents (Unocal 150, Actrel 1171L) were rejected due to their strong hydrocarbon offensive odor which may affect worker’s health. In general, the major sources of odor in petroleum hydrocarbon solvent are listed as aromatic content and the amount of impurities such as sulfur, peroxide, and nitrogen due to the wide distillation temperatures. However, citron odor was not a problem in the ground vehicle cleaning applications.

In aviation applications, four (4) candidate solvents (Breakthrough, Skysol 100, Actrel 1171L, Electron 296) were tested at three military installations. The Ft. Lewis helicopter maintenance shop evaluated Skysol 100 solvent using helicopter parts such as engines, rotors, generators, etc.. This shop uses P-D-680 Type I which provides strong solvency and a fast drying time. Recently, EPA defined P-D-680 Type I solvent as a hazardous material due to its low flash point. For this reason, the Ft. Lewis aviation maintenance shop is currently seeking environmentally friendly solvents which can replace the P-D-680 Type I solvent. Most users reported the solvency of Skysol 100 solvent was adequate to clean soils contaminated in various types of aviation parts. No corrosion and compatibility problems were reported. Citron odor was not a major problem. However, some complaints related to slow drying time were received. Generally, Type II solvents provide slower drying time than Type I due to their higher flash points. This deficiency is minor and can be resolved using air dryers or ovens. Currently, Type II solvent is strongly recommended to replace the Type I as a means to reduce flammability problems. Ft. Hood also evaluated two candidate solvents (Skysol 100, Breakthrough) in helicopter applications such as engines, rotors, generators, etc.. Both solvents were very well accepted in all helicopter maintenance applications. Especially, most users indicated candidate solvents significantly reduce the toxicity (i.e., skin irritation) when compared to P-D-680. Drying time of candidate solvents was the same as for P-D-680 Type II. San
Antonio Logistic Center at Kelly AFB evaluated three candidate solvents (Breakthrough, Actrel 1171L, Electron 296)). In aviation fuel injection repair shop, Breakthrough solvent was very well accepted in comparison to the Actrel 1171L solvent due to its odorless characteristics. Electron 296 solvent was also well accepted by aviation ground supporting equipments such as electric generators. No d-limon odor problem was reported. All candidate hydrocarbon and terpene/hydrocarbon blended solvents were well accepted by aviation users except for the Actrel 1171L solvent. Also, it was observed that d-limon odor was viewed as favorable in open maintenance shops, but a strong offensive hydrocarbon solvent odor was found to be a major problem in all working areas.

P-D-680 solvents are also widely used in weapon cleaning applications. Due to the environmental regulations, this application currently demands a new environmentally acceptable solvent to remove oils, greases, and carbon residue deposited after firing. To determine usability of candidate solvents in weapon applications, Ft. Lewis evaluated three solvents (Breakthrough, Skysol, Skysol 100) using small arms such as the M16 rifle. These candidate solvents were formulated based on the same type of petroleum based hydrocarbon with various amounts of d-limon content and were designed as general solvent cleaners. Breakthrough solvent does not contain any d-limon material, while Skysol solvent has 5% of d-limon content. However, the Skysol 100 solvent contains 10% of d-limon material in order to increase its solvency. All these products are non-carcinogenic and do not contain any ingredients listed by EPCRA, CERCLA, and RCRA. Also, worker exposure is not regulated by OSHA. The test results showed the performance of all candidate solvents was acceptable except for their odor characteristics. Also, it was found all three solvents provided similar solvency in these weapon cleaning applications. Few users reported both Skysol and Skysol 100 solvents tends to occasionally leave slight residues on cleaned parts due to the impurity of d-limon. This problem was not observed at Ft. Hood. Also, Ft. Hood did not find any abnormal behavior of Skysol 100 solvent, and accepted this as a replacement for P-D-680. In these demonstrations, a strong citron odor was a major problem in closed areas of weapon cleaning facilities. Generally, the large variations of odor depend on human sensitivity and are very difficult to control in small closed areas. Odorless products such as Breakthrough solvent were well accepted in both open and closed weapon cleaning facilities.

To reduce waste stream, solvent recycling is common practice in many industries (i.e., Safety Kleen Company) and a wide range of solvents are currently recycled using several different types of distillation techniques. During P-D-680 user survey conducted in Phase I within DOD, most military users expressed their concerns to the current disposal problems of P-D-680 solvents. Although a solvent recycling
demonstration was not conducted in this study, most users observed the recirculation part washers actually served as a recycling unit and significantly extended solvent useful life. It appears this system can reduce solvent waste stream and is a first step to resolve the environmental problems the military currently faces.
Section 4  Conclusions

On the basis of the work completed to date, field demonstrations were successively completed at Army and Air Force installations. The following finding evolved during the field demonstrations.

- Severe hydrotreated odorless hydrocarbon solvents were very well accepted because of their low odor characteristics and less toxicity. Especially, the candidate Type II product is more favored than the Type III due to its faster drying time.

- Hydrotreated terpene/hydrocarbon blended solvents were also very well accepted in all applications. Citron odor was not considered as a major problem in open working areas.

- Odor, cleaning power, corrosion protection and toxicity of solvent were major evaluation selection factors for all cleaning applications.

- Most users did not like to continuously use hydrocarbon solvents having strong offensive odors (i.e., the P-D-680 Types I and II odor).

- Odorless hydrotreated Type II hydrocarbon solvent was acceptable for weapon cleaning applications due to its odorless characteristics.

- All candidate solvents performed well for all applications when compared to P-D-680 solvents which have a strong hydrocarbon odor and medium level of toxicity (i.e., irritation to skin).

- Candidate Type II solvents were found to be acceptable when used in applications requiring Type I.

- Laboratory test results correlated well with field performance.

- The following six candidate solvents were rated by users as acceptable replacements for P-D-680.
<table>
<thead>
<tr>
<th>Type</th>
<th>Solvent Composition</th>
<th>Candidate P-D-680 Solvent</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hydrocarbon</td>
<td>Type II solvent</td>
</tr>
<tr>
<td>II</td>
<td>Hydrocarbon</td>
<td>Breakthrough</td>
</tr>
<tr>
<td>III</td>
<td>Hydrocarbon</td>
<td>134 Hi-Solv</td>
</tr>
<tr>
<td>IV*</td>
<td>Terpene/Hydrocarbon Blend</td>
<td>Skysol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skysol 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electron</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PF</td>
</tr>
</tbody>
</table>

*This is a proposed new Type for P-D-680 and its performance is equivalent to Type II.

Because of the wide application of P-D-680 solvents within DOD, this field demonstration is being extended to validate the performance of the above candidate environmentally compliant solvents for Naval shipboard applications.

References


4. Correspondence from Inland Technology Company, 19 August, 1996.
### Table 2. Laboratory Solvent Test Results

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Flash Point, ºC</th>
<th>Distillation, ºC</th>
<th>Kauri-Butanol value</th>
<th>Non-volatile residue, %</th>
<th>Aniline Point, ºC</th>
<th>Odor</th>
<th>VOC g/l</th>
<th>Evap %, @ 20 min.</th>
<th>Corrosion</th>
<th>Relative Solvency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-D-680 (I)</td>
<td>47.0</td>
<td>165.4</td>
<td>204.6</td>
<td>39</td>
<td>0.1</td>
<td>61.2</td>
<td>strong</td>
<td>789.7</td>
<td>47.1</td>
<td>1a</td>
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<tr>
<td>P-D-680 (II)</td>
<td>63.0</td>
<td>182.8</td>
<td>206.7</td>
<td>32</td>
<td>0.07</td>
<td>73.1</td>
<td>strong</td>
<td>785.8</td>
<td>22.8</td>
<td>1a</td>
</tr>
<tr>
<td>P-D-680 (III)</td>
<td>93.3</td>
<td>223.4</td>
<td>269.0</td>
<td>31</td>
<td>0.3</td>
<td>76.1</td>
<td>odorless</td>
<td>823.2</td>
<td>4.6</td>
<td>1a</td>
</tr>
<tr>
<td>Breakthrough</td>
<td>65.5</td>
<td>184.0</td>
<td>211.7</td>
<td>27</td>
<td>0.05</td>
<td>84.0</td>
<td>odorless</td>
<td>770</td>
<td>25.9</td>
<td>1b</td>
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<tr>
<td>Actrel 1171L</td>
<td>81.1</td>
<td>211.6</td>
<td>241.1</td>
<td>30</td>
<td>0.35</td>
<td>77.8</td>
<td>strong</td>
<td>797</td>
<td>10.1</td>
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<td>Unocal 150</td>
<td>66.7</td>
<td>186.0</td>
<td>212.7</td>
<td>31</td>
<td>0.15</td>
<td>71.2</td>
<td>mild</td>
<td>772</td>
<td>19.1</td>
<td>1b</td>
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<tr>
<td>134 Hi-Solv</td>
<td>97.8</td>
<td>232.4</td>
<td>299.3</td>
<td>24</td>
<td>0.07</td>
<td>94.5</td>
<td>odorless</td>
<td>796</td>
<td>3.8</td>
<td>1b</td>
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<tr>
<td>Skysol</td>
<td>66.7</td>
<td>189.4</td>
<td>212.4</td>
<td>29</td>
<td>0.16</td>
<td>83.0</td>
<td>citrus</td>
<td>770</td>
<td>20.0</td>
<td>1b</td>
</tr>
<tr>
<td>Skysol 100</td>
<td>63.3</td>
<td>189.6</td>
<td>212.7</td>
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<td>0.44</td>
<td>82.8</td>
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<td>780</td>
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<td>1a</td>
</tr>
<tr>
<td>Electron 296</td>
<td>63.9</td>
<td>191.8</td>
<td>235.6</td>
<td>32</td>
<td>0.01</td>
<td>69.1</td>
<td>citrus</td>
<td>782</td>
<td>18.1</td>
<td>1b</td>
</tr>
<tr>
<td>PF</td>
<td>62.2</td>
<td>187.0</td>
<td>228.8</td>
<td>26</td>
<td>0.32</td>
<td>76.7</td>
<td>citrus</td>
<td>760</td>
<td>14.8</td>
<td>1b</td>
</tr>
</tbody>
</table>
### Table 3. Field Testing Sites for P-D-680 Replacement Solvent at Fort Lewis

<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Location</th>
<th>Candidate Solvent</th>
<th>Designated Type to P-D-680</th>
<th>Military Equipment</th>
<th>Cleaning Method</th>
<th>Specified Cleaning Solvent</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLT-1</td>
<td>Bldg: 9580 Unit: 296th DS*/DOL Maintenance Shop POC: Chief Richardson Tel: 967-6915</td>
<td>Breakthrough (Hydrocarbon)</td>
<td>II</td>
<td>M-1 Tank Engine Parts, Track Vehicle Parts</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-2</td>
<td>Bldg: 3750 Unit: 296th, B Co. DS Maintenance Shop POC: Chief Richardson Tel: 967-6915</td>
<td>134 Hi-Solv (Hydrocarbon)</td>
<td>III</td>
<td>Track and Wheeled Vehicles, M998 series, M113 series, M994 series, M931 series, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-3</td>
<td>Bldg: 3960 Unit: 542nd MT DS Maintenance Shop POC: Chief Jones Tel: 967-6667</td>
<td>Actrel 1171L (Hydrocarbon)</td>
<td>II</td>
<td>Wheeled Vehicles, Automotive Rolling Stock, Hydraulic system, Transmission system</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-4</td>
<td>Bldg: 3945 Unit: 1-37 FA DS Maintenance Shop POC: MSG Carney Tel: 967-6653</td>
<td>Unocal 150 (Hydrocarbon)</td>
<td>II</td>
<td>Track and Wheeled Vehicles; Wheel bearings, Hydraulic system, Engine, transmission, Fuel system, Mechanical parts, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electron 296 (Terpene/Hydrocarbon blend)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electron 296 (Terpene/Hydrocarbon blend)</td>
<td>IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Testing Site</td>
<td>Location</td>
<td>Candidate Solvent</td>
<td>Designated Type to P-D-680</td>
<td>Military Equipment</td>
<td>Cleaning Method</td>
<td>Specified Cleaning Solvent</td>
</tr>
<tr>
<td>--------------------</td>
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</tr>
<tr>
<td>FLT-5</td>
<td>Bldg: 3943 Unit: I-37 A/B Battery Maintenance Shop POC: MSG Carney Tel: 967-6653</td>
<td>PF (Terpene/Hydro carbon Blend)</td>
<td>IV</td>
<td>Track Vehicles; wheel bearing, accessory, mechanical parts, power train system, engine components, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edge tek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-6</td>
<td>Bldg: 3941 Unit: I-37 FA Vehicle maintenance shop POC: MSG Carney Tel: 967-6653</td>
<td>Breakthrough</td>
<td>II</td>
<td>Track Vehicles; Wheel bearings, Mechanical parts, Hydraulic system, Transmission, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edge tek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-7</td>
<td>Bldg: 3957 Unit: 542nd MT Maintenance Shop POC: Chief Jones Tel: 967-6667</td>
<td>Acetrel 1171L</td>
<td>II</td>
<td>Engineering Equipment, Power Generation Equipment, Hydraulic control valve, Spool valve, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edge tek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-8</td>
<td>Bldg: 2071 Unit: 63rd ORD Vehicle maintenance shop POC: Chief Fields Tel: 967-6889</td>
<td>Skysol 100 (Terpene/Hydro carbon Blend)</td>
<td>IV</td>
<td>Engineering Equipment, Wheel vehicles; M998, M1074, M939, ATFL 6K, 40T Crane, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edge tek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-9</td>
<td>Bldg: 2057 Unit: 528th QM Maintenance Shop POC: Chief Wycoff Tel: 967-5653</td>
<td>Unocal 150 (Hydrocarbon)</td>
<td>II</td>
<td>Wheeled vehicles; M939 series, M998, M916, M35A2, DF7 Dozer, M10A Forklift, 350 GPM Pumps, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edge tek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-10</td>
<td>Bldg: 2059 Unit: 497th TRAN Maintenance Shop POC: Chief Vicent Tel: 967-5404</td>
<td>134 Hi-Solv</td>
<td>III</td>
<td>Large wheeled vehicles; M923, M998, M931, A-1, A-2, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edge tek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>Field Testing Site</td>
<td>Location</td>
<td>Candidate Solvent</td>
<td>Designated Type to P-D-680</td>
<td>Military Equipment</td>
<td>Cleaning Method</td>
<td>Specified Cleaning Solvent</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------</td>
<td>-------------------</td>
<td>---------------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>FLT-11</td>
<td>Bldg: 9160 Unit: 1st SFG, S-4 SEV DET POC: SGT Haddow-Green Tel: 967-8735</td>
<td>Skysol 100 (Terpene/Hydro carbon Blend)</td>
<td>IV</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-12</td>
<td>Bldg: 9181 Unit: 1st SFG, GSC POC:Ssgt Hareld Tel: 967-8916</td>
<td>Skysol 100 (Terpene/Hydro carbon Blend)</td>
<td>IV</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-13</td>
<td>Bldg: 9162 Unit: 1st SFG, 3rd BN POC:Sfc Lance Tel: 967-8811</td>
<td>Skysol 100 (Terpene/Hydro carbon Blend)</td>
<td>IV</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-14</td>
<td>Bldg: 3280 Unit: 2-8 FA POC:Cpl Swinton Tel: 967-1858</td>
<td>Skysol 100 (Terpene/Hydro carbon Blend)</td>
<td>IV</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>Field Testing Site</td>
<td>Location</td>
<td>Candidate Solvent</td>
<td>Designated Type to P-D-680</td>
<td>Military Equipment</td>
<td>Cleaning Method</td>
<td>Specified Cleaning Solvent</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>-------------------</td>
<td>-----------------------------</td>
<td>--------------------</td>
<td>----------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>FLT-15</td>
<td>Bldg: 3766D Unit: 1-23 Inf, 3rd BCT POC:Sgt Gonzales Tel: 967-9167</td>
<td>Breakthrough (Hydrocarbon)</td>
<td>II</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgetek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-16</td>
<td>Bldg: North Fort ROTC Unit: ROTC POC:Alice Murrell Tel: 967-4202 Cleaning Station : 2</td>
<td>Skysol™ (Terpene/Hydrocarbon Blend)</td>
<td>IV</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgetek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-17</td>
<td>Bldg: 3098 Unit: ATCOM OLR POC:Tom Maniglia Tel: 967-2409</td>
<td>Skysol 100 (Terpene/Hydrocarbon blend)</td>
<td>IV</td>
<td>Aircraft/Parts, CH-47, UH-60, OH-58, AH-1, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgetek filter system</td>
<td>P-D-680 Type I supplied by Safety Kleen Company</td>
</tr>
<tr>
<td>FLT-18</td>
<td>Bldg: 3390 Unit: 864th ENG BN, HHC POC:2nd Lt Warder Tel: 967-5873</td>
<td>PF (Terpene/Hydrocarbon Blend)</td>
<td>IV</td>
<td>Engineering Equipment; M998, M1074, M939, M916, ATFL 6K, 40T Cranes.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgetek filter system</td>
<td>P-D-680 Type II supplied by Safety Kleen Company</td>
</tr>
</tbody>
</table>

* Proposed P-D-680 Type II

** Substitute solvent for only weapon cleaning application
<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Location</th>
<th>Candidate Solvent</th>
<th>Designated Type to P-D-680</th>
<th>Military Equipment</th>
<th>Cleaning Method</th>
<th>Specified Cleaning Solvent</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHT-1</td>
<td>Bldg: 6970 Unit: Helicopter Engine Repair Shop POC: Mr. McKenzie Tel: 288-3252</td>
<td>Breakthrough (Hydrocarbon)</td>
<td>II</td>
<td>All types of helicopter engines; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-48 weapon cleaning system with edge Becker filter system</td>
<td>P-D-680 Type II supplied by DSCR</td>
</tr>
<tr>
<td>FHT-2</td>
<td>Bldg: 7012 Unit: Helicopter Propeller Rotor Repair Shop POC: Mr. Stinson Tel: 287-2539</td>
<td>Skysol 100 (Terpene/Hydrocarbon Blend)</td>
<td>IV*</td>
<td>All types of helicopter propeller rotors; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc.</td>
<td>Remove grease/oil using hand cleaning procedure and IT-48 weapon cleaning system with edge Becker filter system</td>
<td>P-D-680 Type II supplied by DSCR</td>
</tr>
<tr>
<td>FHT-3</td>
<td>Bldg: 6975 Unit: Aviation Maintenance Service Branch POC: Mr. Bayness Tel: 288-3510</td>
<td>Skysol 100 (Terpene/Hydrocarbon Blend)</td>
<td>IV</td>
<td>Helicopter weapon system, small arms; 30mm Caliber</td>
<td>Remove grease/oil/ carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edge Becker filter system</td>
<td>P-D-680 Type II supplied by DSCR</td>
</tr>
<tr>
<td>FHT-4</td>
<td>Bldg: 739 Unit: Helicopter Generator Repair Shop POC: Mr. Chuk Tel: 288-3560</td>
<td>Breakthrough (Hydrocarbon)</td>
<td>II</td>
<td>Helicopter electric generator parts</td>
<td>Remove grease/oil/ carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edge Becker filter system</td>
<td>P-D-680 Type II supplied by DSCR</td>
</tr>
</tbody>
</table>

* Proposed P-D-680 Type
# Table 5. Field Testing Sites for P-D-680 Replacement Solvent at Kelly Air Force Base

<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Location</th>
<th>Candidate Solvent</th>
<th>Designated Type to P-D-680</th>
<th>Military Equipment</th>
<th>Cleaning Method</th>
<th>Specified Cleaning Solvent</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAT-1</td>
<td>Bldg: 348 Unit: Aviation Fuel Accessories Repair Shop POC: Mr. Huron Tel: 210-925-7554</td>
<td>Breakthrough (Hydrocarbon)</td>
<td>II</td>
<td>All types of aircraft fuel control system; F15, F16, C58, C130, C131, etc.</td>
<td>Remove grease/oil/carbon deposit using hand cleaning procedure and two bench types of cleaner and one spray gun part washer. All these part washers are recirculated system.</td>
<td>P-D-680 Type II supplied by DSCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Actrel 1171L (Hydrocarbon)</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skysol 100 (Terpene/Hydrocarbon Blend)</td>
<td>IV*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KAT-2</td>
<td>Bldg: 894 Unit: 433rd AGE Shop POC: Jim Barajas Tel: 210-977-4098</td>
<td>Electron 296 (Terpene/Hydrocarbon Blend)</td>
<td>IV</td>
<td>Aerospace ground supporting equipment</td>
<td>Remove grease/oil/using part washers</td>
<td>P-D-680 Type II supplied by DSCR</td>
</tr>
</tbody>
</table>

* Proposed P-D-680 Type
# Table 6. Field Test Results from Fort Lewis

<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Candidate Solvent</th>
<th>Total Response</th>
<th>Military Equipment</th>
<th>Comments</th>
<th>CPP</th>
<th>EAP</th>
<th>Total Point</th>
<th>Ranking</th>
</tr>
</thead>
</table>
| FLT-1              | Breakthrough      | 21             | M-1 Tank Engine Parts, Track Vehicle Parts | . No residue problem  
. Strong solvency  
. No odor  
. Less toxic than P-D-680  
. Acceptable solvent | 40   | 45   | 85   | Good   |
| FLT-2              | 134 Hi-Solv       | 3              | Track and Wheeled Vehicles, M998 series, M113 series, M994 series, M931 series, etc. | . Slow drying time  
. No odor  
. No residue problem  
. Good solvency  
. Useful solvent | 45   | 43   | 88   | Good   |
| FLT-3              | Actrel 1171L      | 18             | Wheeled Vehicles, Automotive Rolling Stock, Hydraulic system, Transmission system | . Very strong solvent  
. No residue problem  
. Strong hydrocarbon odor  
. Same as P-D-680  
. Not favorite | 39   | 33   | 72   | Average |
|                    | (Hydrocarbon)     |                | Electron 296 (Terpene/Hydrocarbon blend) | . Acceptable citron odor  
. Strong solvency  
. No residue problem  
. Less toxic than P-D-680  
. No corrosion  
. No compatibility problem  
. Normal drying time  
. Acceptable solvent | 45   | 40   | 85   | Good   |
<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Candidate Solvent</th>
<th>Total Response</th>
<th>Military Equipment</th>
<th>Comments</th>
<th>CPP</th>
<th>EAP</th>
<th>Total Point</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLT-4</td>
<td>Unocal 150 (Hydrocarbon)</td>
<td>5</td>
<td>Track and Wheeled Vehicles; Wheel bearings, Hydraulic system, Engine, transmission, Fuel system, Mechanical parts, etc.</td>
<td>Very strong solvent. Strong hydrocarbon odor. Fast drying. No residue problem. Good performance. Same as P-D-680.</td>
<td>45</td>
<td>25</td>
<td>70</td>
<td>Average</td>
</tr>
<tr>
<td>FLT-6</td>
<td>PF (Terpene/Hydrocarbon Blend)</td>
<td>8</td>
<td>Track Vehicles; wheel bearing, accessory, mechanical parts, power train system, engine components, etc.</td>
<td>Citron odor. Milder solvent. Good performance. Less toxic than P-D-680. No residue problem. Acceptable solvent.</td>
<td>45</td>
<td>40</td>
<td>85</td>
<td>Good</td>
</tr>
<tr>
<td>FLT-7</td>
<td>Breakthrough</td>
<td>25</td>
<td>Track Vehicles; Wheel bearings, Mechanical parts, Hydraulic system, Transmission, etc.</td>
<td>No odor. Good cleaning power. No residue problem. No corrosion. Fast drying time. No irritation to skin. Acceptable solvent.</td>
<td>44</td>
<td>44</td>
<td>88</td>
<td>Good</td>
</tr>
<tr>
<td>FLT-7</td>
<td>Acetrel 1171L (Hydrocarbon)</td>
<td>9</td>
<td>Engineering Equipment, Power Generation Equipment, Hydraulic control valve, Spool valve, etc.</td>
<td>Strong hydrocarbon odor. Strong solvency. Same as P-D-680. Not favorable.</td>
<td>41</td>
<td>25</td>
<td>66</td>
<td>Poor</td>
</tr>
<tr>
<td>Field Testing Site</td>
<td>Candidate Solvent</td>
<td>Total Response</td>
<td>Military Equipment</td>
<td>EAP</td>
<td>CPP</td>
<td>Comments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>FLT-9</td>
<td>Unocal 150 (Hydrocarbon)</td>
<td>16</td>
<td>Wheeled vehicles, wheeled M998, M107/4, M939, M933, M925, etc.</td>
<td>40</td>
<td>46</td>
<td>Citron odor, lower cost, no corrosion, strong solvent power, strong cleaning power, medium drying time, no irritation to skin, acceptable solvent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLT-10</td>
<td>134 Hi-Solv.</td>
<td>4</td>
<td>Large wheeled vehicles, M998, M901, M10A Forklift, 350 GPM Pumps, etc.</td>
<td>43</td>
<td>40</td>
<td>Less odor, less drying time, medium cleaning power, no irritation to skin, acceptable solvent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLT-11</td>
<td>Skydrol 100 (Terpene/Hydrocarbon Blend)</td>
<td>19</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>82</td>
<td>44</td>
<td>Citron odor, less toxic than P-D-680, good carbon remover, no corrosion, acceptable solvent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLT-12</td>
<td>Skydrol 100 (Terpene/Hydrocarbon Blend)</td>
<td>13</td>
<td>M2, M16 Rifle, M-60, Small Arms</td>
<td>78</td>
<td>38</td>
<td>Strong citron odor in office space, 3000 man hours over cleaning application, 2000 weapon cleaning application, 2000 weapon cleaning application, less toxic than P-D-680, no corrosion, acceptable solvent.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Candidate Solvent: Skydrol 100 (Terpene/Hydrocarbon Blend)
<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Candidate Solvent</th>
<th>Total Response</th>
<th>Military Equipment</th>
<th>Comments</th>
<th>CPP 1</th>
<th>EAP 2</th>
<th>Total Point</th>
<th>Ranking</th>
</tr>
</thead>
</table>
| FLT-13             | Skysol 100        | 4              | M2, M16 Rifle, M-60, Small Arms | . Citron odor  
. Good cleaning power  
. Safe solvent  
. Acceptable solvent | 48     | 36     | 84     | Good    |
| FLT-14             | Skysol 100        | Interview      | M2, M16 Rifle, M-60, Small Arms | . Citron odor  
. Milder solvent  
. Good performance  
. Acceptable solvent | 42     | 40     | 82     | Good    |
| FLT-15             | Breakthrough      | 57             | M2, M16 Rifle, M-60, Small Arms | . No odor  
. No corrosion  
. Good performance  
. Slight residue problem  
. Drying time same as P-D-680 Type II  
. Acceptable solvent in small office space | 43     | 42     | 85     | Good    |
| FLT-16             | Skysol             | 425            | M2, M16 Rifle, M60, Small Arms | . Less citron odor  
. Good solvency  
. Slight residue problem  
. Same as Breakthrough solvent  
. Acceptable solvent | 43     | 41     | 84     | Good    |
| Breakthrough       | Hydrocarbon       | 72             |                    | . No odor  
. Good solvency  
. Less toxic than P-D-680  
. No residue  
. No corrosion  
. No compatibility problem  
. Acceptable solvent | 40     | 45     | 85     | Good    |
<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Candidate Solvent</th>
<th>Total Response</th>
<th>Military Equipment</th>
<th>Comments</th>
<th>CPP¹</th>
<th>EAP²</th>
<th>Total Point</th>
<th>Ranking</th>
</tr>
</thead>
</table>
| FLT-17             | Skysol 100        | 25             | Aircraft/Parts, CH-47, UH-60, OH-58, AH-1 | . No odor problem  
. Good cleaner  
. No corrosion  
. Slow drying time  
. Acceptable solvent | 40   | 40   | 80   | Good   |
| FLT-18             | PF                | 7              | Engineering Equipment, Wheeled vehicles; M998, M1074, M939, M916, ATFL 6K, 40T Cranes | . Citrus odor  
. Good solvency  
. Normal drying time  
. No corrosion  
. No residue  
. No compatibility problem  
. Less toxic than P-D-680  
. Acceptable solvent | 45   | 44   | 89   | Good   |

1. Cleaning Performance Point  
2. Environmental Assessment Point
<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Candidate Solvent</th>
<th>Total Response</th>
<th>Military Equipment</th>
<th>Comments</th>
<th>CPP</th>
<th>EAP</th>
<th>Total Point</th>
<th>Ranking</th>
</tr>
</thead>
</table>
| FHT-1              | Breakthrough (Hydrocarbon)  | 2              | All types of helicopter engines; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc. | . No odor  
. Solvency is same as P-D-680  
. No corrosion  
. No residue  
. Less toxic than P-D-680  
. Good performance  
. Acceptable solvent | 45   | 45   | 90                       | Excellent |
| FHT-2              | Skysol 100 (Terpene/Hydrocarbon Blend) | 2              | All types of helicopter propeller rotors; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc. | . Citron odor (better than P-D-680 odor)  
. Slow evaporation  
. Good performance  
. No irritation to skin  
. No residue  
. Acceptable solvent | 47   | 40   | 87                       | Good   |
| FHT-3              | Skysol 100 (Terpene/Hydrocarbon Blend) | 2              | Helicopter weapon system, small arms; 30mm Caliber | . No odor problem  
. Good cleaning power  
. No irritation to skin  
. No corrosion  
. Acceptable solvent | 48   | 40   | 88                       | Good   |
| FHT-4              | Breakthrough (Hydrocarbon)  | 2              | Helicopter electric generator and starter parts | . No odor  
. Milder solvent  
. No corrosion  
. No irritation to skin  
. Acceptable solvent | 45   | 93   |                         | Excellent |

1. Semi-overall report  
2. Cleaning Performance Points  
3. Environmental Assessment Points
<table>
<thead>
<tr>
<th>Field Testing Site</th>
<th>Candidate Solvent</th>
<th>Total Response</th>
<th>Military Equipment</th>
<th>Comments</th>
<th>CPP</th>
<th>EAP</th>
<th>Total Point</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAT-1</td>
<td>Breakthrough (Hydrocarbon)</td>
<td>6</td>
<td>All types of aircraft fuel control system; F15, F16, C58, C130, C131, etc.</td>
<td>. No odor . Excellent cleaning power . No corrosion . No residue . Fast drying time . No compatibility problem . Acceptable solvent</td>
<td>48</td>
<td>45</td>
<td>93</td>
<td>Excellent</td>
</tr>
<tr>
<td></td>
<td>Skysol 100 (Terpene/Hydrocarbon Blend)</td>
<td>None</td>
<td></td>
<td>. No data</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. Cleaning Performance Point  2. Environmental Assessment Point
Appendices
### Appendix A-1. Test Protocol for Alternative P-D-680 Solvents

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point</td>
<td>ASTM D 56</td>
</tr>
<tr>
<td>Distillation</td>
<td>ASTM D 86</td>
</tr>
<tr>
<td>Kauri-Butanol value</td>
<td>ASTM D 1133</td>
</tr>
<tr>
<td>Aniline point</td>
<td>ASTM D 611</td>
</tr>
<tr>
<td>Odor</td>
<td>ASTM D 1298</td>
</tr>
<tr>
<td>Non-volatile residue</td>
<td>TGA*</td>
</tr>
<tr>
<td>Evaporation @ 50 °C, 20 min</td>
<td>TGA</td>
</tr>
<tr>
<td>Copper corrosion</td>
<td>ASTM D 130</td>
</tr>
<tr>
<td>Steel corrosion</td>
<td>Modified ASTM D 130</td>
</tr>
<tr>
<td>VOC content</td>
<td>EPA method 24</td>
</tr>
<tr>
<td>Relative solvency</td>
<td>Army soil test method</td>
</tr>
</tbody>
</table>

* Thermogravimetric Analysis
### Appendix A-2. P-D-680 Specification Requirements

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point, °C, min</td>
<td>38.0 (100 °F)</td>
<td>60.0 (140 °F)</td>
<td>93.3 (200 °F)</td>
</tr>
<tr>
<td>Distillation, °C:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial boiling pt., min</td>
<td>208</td>
<td>211</td>
<td>295</td>
</tr>
<tr>
<td>50 % recovered</td>
<td>149</td>
<td>177</td>
<td>220</td>
</tr>
<tr>
<td>Dry point, °C, max</td>
<td>Report</td>
<td>Report</td>
<td>Report</td>
</tr>
<tr>
<td>Aniline point, °C</td>
<td>57 to 74</td>
<td>57 to 74</td>
<td>73 to 89</td>
</tr>
<tr>
<td>Kauri-butanol value</td>
<td>20 to 45</td>
<td>29 to 45</td>
<td>27 to 45</td>
</tr>
<tr>
<td>Allowable constituents, (% by volume):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Solvent with olefinic or cyclo-olefinic</td>
<td>5</td>
<td>5</td>
<td>0.8</td>
</tr>
<tr>
<td>(b) Aromatic compounds with eight or more carbon atoms, except ethylbenzene, max</td>
<td>8</td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>(c) Total of ethylbenzene, toluene, and branched chain ketones, max</td>
<td>20</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>(d) Total of (a) + (b) + (c), max</td>
<td>20</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Total chlorine content (ppm) max</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Apparent specific Gravity</td>
<td>0.754 to 0.820</td>
<td>0.754 to 0.820</td>
<td>0.740 to 0.840</td>
</tr>
<tr>
<td>Non-volatile residue (mg/100 mL), max</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Color, min</td>
<td>25</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Odor 2/ Character &amp; non-residual</td>
<td>2A</td>
<td>2A</td>
<td>2A</td>
</tr>
<tr>
<td>Corrosion, copper, max 3/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidity</td>
<td>neutral</td>
<td>neutral</td>
<td>neutral</td>
</tr>
<tr>
<td>Doctor test</td>
<td>negative</td>
<td>negative</td>
<td>negative</td>
</tr>
<tr>
<td>Vapor pressure, Torr @ 20 °C, max</td>
<td>-</td>
<td>-</td>
<td>0.40</td>
</tr>
<tr>
<td>Total phenol content (ppm), max</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Viscosity, cSt at 25 °C, max</td>
<td>-</td>
<td>-</td>
<td>5.0</td>
</tr>
</tbody>
</table>

1/ These maximum limits are as defined in rule 102, South Coast Air Quality Management District regulations.
Appendix B. Solvent Evaluation Sheet
Solvent Evaluation Sheet for P-D-680 Replacements

1. User Category
What class of material is cleaned by P-D-680 solvents?
(e.g., weapons, artillery, armored, tactical vehicles, combat services support,
aircrafts, ships, bearings, etc...)

What is your organization and installation?

Please provide your name, title, address and phone number:

2. Evaluation of Current P-D-Solvents
What types of P-D-680 solvents are you currently using to clean weapons,
vehicles, or other equipment? (e.g., types 1, 2, 3)

Are you currently using other than P-D-680 solvents?

What problems have you experienced with current P-D-680 solvents?

What do you like about current P-D-680 solvents?
What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

3. **Evaluating Alternative P-D-680 Solvents**
   Name of solvent:

   What type of cleaning method(s) did you use to evaluate this solvent? (short description)

   What types of equipment or parts were used to evaluate this solvent?

   What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

   What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

   Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)
Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,...etc.)

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

When compared this solvent with P-D-680, which product is better fitted for your applications?

Overall, what rating would you give for this solvent? (accept, or reject)

4. Health, Safety of Alternative P-D-680 Solvent
Have you, or did you have knowledge of others that may have experienced nausea, skin rashed, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

Did you see any possible flammability problems with using this solvent?
5. **Speak Out!**

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product.

6. **This solvent evaluation sheet should be returned as soon as possible after completion of field test:**

Department of the Army  
Mobility Technology Center - Belvoir  
Attn AMSTA RBF (MR I RHEE)  
10115 Gridely Rd STE 128  
Fort Belvoir, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants technology Team  
Telephone: (703) 704-1824 or DSN 654-1824  
Fax: (703) 704-1822
Appendix C-1. Typical field Data obtained from Fort Lewis, WA

a. Ground Equipment Application

b. Weapon Cleaning Application

c. Aviation Application
a. Ground Equipment Application

- Breakthrough
- 134 Hi-Solv
- Actrel 1171L
- Electron 296
- PF
- Skysol 100
- Unocal 150
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-012

Date: 9/3/96
Name: Lewis

Type of Part Cleaned (e.g. wheel bearings): Oil Tank engine lines

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)
   5 4 3 2 1
   Heavily soiled..........................moderately soiled..........................lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)
   Grease  Oil  Dirt  Mud  Other (Describe) ____________

3. Please rate the solvency (cleaning characteristics) of this solvent?
   5 4 3 2 1
   excellent..........................good..........................average..........................poor

   Remarks (If any): ________________________________________________________

4. What is your rating as to its drying time or how quickly did it evaporate?
   5 4 3 2 1
   fast..........................normal..........................slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?
   YES  NO

   If yes, please explain what kind (e.g. pitting, rust, etc.): __________________________

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,...etc.)
   YES  NO

   If yes, please explain and list the particular part cleaned: ________________________________

7. Did you observe any residue on the part after using this solvent?
   YES  NO

8. Did you smell any odor?
   YES  NO

   If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless,...etc.)

9. Did you see any possible flammability problems with using this solvent?
   YES  NO

10. Rate this solvent's acceptability for cleaning your part?
    5 4 3 2 1
    Highly acceptable..........................Acceptable..........................Reject

   REMARKS:
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-011

Date: 23-4-96
Name: ??

Type of Part Cleaned (e.g. wheel bearings): Engine Assembly

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

   6) 4 3 2 1
   Heavily soiled                           moderately soiled                           lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

   Grease   Oil   Dirt   Mud   Other (Describe) __________

3. Please rate the solvency (cleaning characteristics) of this solvent?

   5 4 3 2 1
   excellent                           good                           average                           poor

   Remarks (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?

   5 4 3 2 1
   fast                           normal                           slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

   YES   NO

   If yes, please explain what kind (e.g. pitting, rust, etc.):

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)

   YES   NO

   If yes, please explain and list the particular part cleaned:

7. Did you observe any residue on the part after using this solvent?

   YES   NO

8. Did you smell any odor?

   YES   NO

   If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)

9. Did you see any possible flammability problems with using this solvent?

   YES   NO

10. Rate this solvent's acceptability for cleaning your part?

    5 4 3 2 1
    Highly acceptable                           Acceptable                           Reject

   REMARKS:
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-008

Date: [Signature]
Name: [Signature]

Type of Part Cleaned (e.g. wheel bearings): Oily Basket

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5  4  3  2  1
Heavily soiled..........................moderately soiled..........................lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease  Oil  Dirt  Mud  Other (Describe)

3. Please rate the solvency (cleaning characteristics) of this solvent?

5  4  3  2  1
excellent..........................good..........................average..........................poor

Remarks (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?

5  4  3  2  1
fast..........................normal..........................slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES  NO

If yes, please explain what kind (e.g. pitting, rust, etc.):

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)

YES  NO

If yes, please explain and list the particular part cleaned:

7. Did you observe any residue on the part after using this solvent?

YES  NO

8. Did you smell any odor?

YES  NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)

9. Did you see any possible flammability problems with using this solvent?

YES  NO

10. Rate this solvent's acceptability for cleaning your part?

5  4  3  2  1
Highly acceptable..........................Acceptable..........................Reject

REMARKS: Needs stronger water support
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS  
TANK ID: ST-009

Date: 24 June 96  
Name: SRC washer

Type of Part Cleaned (e.g. wheel bearings): Oil Drum Buckets 2 ea.

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavily soiled</td>
<td>moderately soiled</td>
<td>lightly soiled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. What type of media did you remove from the part? (Circle all that apply)

- Grease
- Oil
- Dirt
- Mud
- Other (Describe) __________

3. Please rate the solvency (cleaning characteristics) of this solvent?

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>excellent</td>
<td>good</td>
<td>average</td>
<td>poor</td>
<td></td>
</tr>
</tbody>
</table>

Remarks (If any): Took oil off quickly

4. What is your rating as to its drying time or how quickly did it evaporate?

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>fast</td>
<td>normal</td>
<td>slow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

- YES
- NO

If yes, please explain what kind (e.g. pitting, rust, etc.): _______________________

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)

- YES
- NO

If yes, please explain and list the particular part cleaned: _______________________

7. Did you observe any residue on the part after using this solvent?

- YES
- NO

8. Did you smell any odor?

- YES
- NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)

Nice citrus odor

9. Did you see any possible flammability problems with using this solvent?

- YES
- NO

10. Rate this solvent's acceptability for cleaning your part?

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly acceptable</td>
<td>Acceptable</td>
<td>Reject</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REMARKS: ____________________________
### SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

**Date:** 12/09/96  
**Tank ID:** ST-014  
**Name:** Smith Ralph A  
**Type of Part Cleaned:** Air Dryer

#### 1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavily soiled</td>
<td>Moderately soiled</td>
<td>Lightly soiled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2. What type of media did you remove from the part? (Circle all that apply)

- Grease
- Oil
- Dirt
- Mud
- Other (Describe): __________

#### 3. Please rate the solvency (cleaning characteristics) of this solvent?

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>Good</td>
<td>Average</td>
<td>Poor</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks (If any):** __________

#### 4. What is your rating as to its drying time or how quickly did it evaporate?

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast</td>
<td>Normal</td>
<td>Slow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, etc.)

- YES
- NO

#### 6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)

- YES
- NO

#### 7. Did you observe any residue on the part after using this solvent?

- YES
- NO

#### 8. Did you smell any odor?

- YES
- NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)

**Smell:** __________

#### 9. Did you see any possible flammability problems with using this solvent?

- YES
- NO

#### 10. Rate this solvent's acceptability for cleaning your part?

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly acceptable</td>
<td>Acceptable</td>
<td>Reject</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

Date: 22/03/96
Name:

TANK ID: ST-001

Type of Part Cleaned (e.g. wheel bearings):

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

   5  4  3  2  1
   Heavily soiled........................moderately soiled........................lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

   Grease  Oil  Dirt  Mud  Other (Describe)

3. Please rate the solvency (cleaning characteristics) of this solvent?

   5  4  3  2  1
   excellent........................good........................average........................poor

   Remarks (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?

   5  4  3  2  1
   fast........................normal........................slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

   YES  NO

   If yes, please explain what kind (e.g. pitting, rust, etc.):

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)

   YES  NO

   If yes, please explain and list the particular part cleaned:

7. Did you observe any residue on the part after using this solvent?

   YES  NO

8. Did you smell any odor?

   YES  NO

   If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)

   Citrus

9. Did you see any possible flammability problems with using this solvent?

   YES  NO

10. Rate this solvent's acceptability for cleaning your part?

    5  4  3  2  1
    Highly acceptable........................Acceptable........................Reject

REMARKS:
1. What class of material is cleaned by P-D-680 solvents? (e.g., artillery, armored, tactical vehicles, combat service support, aircraft, etc.)

Artillery

2. What is your organization/Installation?

SERVICE STRY

3. Provide your name, title, address, and phone number.

Mariano Delao

4. What types of P-D-680 solvents are you currently using to clean vehicles or other equipment? (e.g., types LIT.112, PW.50-680)

TUNNEL CLEAN (HAND)

5. Are you currently using other than P-D-680 solvents?

No

6. What problems have you experienced with current P-D-680 solvents?

________________________________________

________________________________________

________________________________________

7. What do you like about current P-D-680 solvents?

________________________________________

________________________________________

________________________________________

8. What don't you like about current P-D-680 solvents?

________________________________________

________________________________________

________________________________________

9. What type of P-D-680 solvents do you like that fit your applications?

________________________________________

________________________________________

________________________________________

10. Name of solvent?

Unocal

11. Did you receive training on how to use the parts washer?  No

12. What type of cleaning method(s) did you use to evaluate this solvent?

PW VS HAND

13. What types of equipment or parts were used to evaluate this solvent? (what did you clean in the parts washer? i.e., wheel bearings...) 

TURRET PART
14. What is your opinion on the solvency of this solvent? (i.e., cleaning characteristics, excellent, good, average, poor)
   
   Excellent

15. What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)
   
   Slow

16. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, etc.)
   
   No

17. Did you observe any incompatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)
   
   No

18. Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)
   
   Strong odor, solvent smell

19. When comparing this solvent with P-D-680, which product is better fitted for your applications?
   
   N/A

20. Overall, what rating would you give for this solvent? (accept, reject)
   
   Reject

21. Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.
   
   No

22. Did you see any possible flammability problems with using this solvent?
   
   No.

23. SPEAK OUT! Please discuss anything else pertaining to the tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product.
   
   It swells better, I wished it were right off.
b. Weapon Cleaning Application

- Skysol 100
- Skysol
- Breakthrough
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

Date: 19 June 96
Name: Danny

Type of Part Cleaned (e.g. wheel bearings): CH 970 EXC

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)
   
   5. Heavily soiled
   4. Moderately soiled
   3. Lightly soiled
   2. Slightly soiled
   1. New

2. What type of media did you remove from the part? (Circle all that apply)
   
   ☐ Grease
   ☐ Oil
   ☐ Dirt
   ☐ Mud
   ☐ Other (Describe)

3. Please rate the solvency (cleaning characteristics) of this solvent?
   
   5. Excellent
   4. Good
   3. Average
   2. Poor

   Remarks (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?
   
   5. Fast
   4. Normal
   3. Slow
   2. Very slow
   1. Very slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?
   
   ☐ YES
   ☐ NO

   If yes, please explain what kind (e.g. pitting, rust, etc.):

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, etc.)
   
   ☐ YES
   ☐ NO

   If yes, please explain and list the particular part cleaned:

7. Did you observe any residue on the part after using this solvent?
   
   ☐ YES
   ☐ NO

8. Did you smell any odor?
   
   ☐ YES
   ☐ NO

   If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, etc.)

9. Did you see any possible flammability problems with using this solvent?
   
   ☐ YES
   ☐ NO

10. Rate this solvent's acceptability for cleaning your part?
    
    5. Highly acceptable
    4. Acceptable
    3. Slightly acceptable
    2. Unacceptable
    1. Unacceptable

REMARKS:
R.O.T.C. SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS
TANK ID: WC-001-002

Date: 25 Jul 96

Name: HALL, ZACHARY X

Type of WEAPON CLEANED M-16A-1

1. What Type of Ammunition was used 5.56 Blank

2. How many rounds fired 200

3. Please rate the solvency (cleaning characteristics) of this solvent?
   5 ......................................... excellent
   4 ......................................... good
   3 ......................................... average
   2 ......................................... poor

   REMARKS (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?
   5 ......................................... fast
   4 ......................................... normal
   3 ......................................... slow
   2 ......................................... extremely slow
   1 ......................................... very slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.)
   YES ......................................... NO

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,...etc.)
   YES ......................................... NO

7. Did you observe any residue on the part after using this solvent? YES ......................................... NO

8. Did you smell any odor? YES ......................................... NO

   if yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)
   mild to no smell

9. Did you see any possible flammability problems with using this solvent? YES ......................................... NO

10. Rate this solvent's acceptability for cleaning your part?
    5 ......................................... Highly acceptable
    4 ......................................... Acceptable
    3 ......................................... Satisfactory
    2 ......................................... Marginal
    1 ......................................... Reject

11. How long did it take you to clean your weapon? 4 min

12. How long did it previously take you to clean your weapon? 2.3 hrs

13. What did you previously use to clean your weapon? BREEK FREE

REMARKS:
R.O.T.C. SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: WC-001WC002

Date: 6/6/20

Name: 

Type of WEAPON CLEANED

1. What Type of Ammunition was used

2. How many rounds fired

3. Please rate the solvency (cleaning characteristics) of this solvent?
   
   excellent........................................good........................................average........................................poor
   
   REMARKS (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?
   
   fast................................................normal............................................slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?
   (e.g., pitting, rust, ...etc.)
   
   YES

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, ... etc.)
   
   YES

7. Did you observe any residue on the part after using this solvent?
   
   YES

8. Did you smell any odor?
   
   YES
   
   if yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ... etc.)

9. Did you see any possible flammability problems with using this solvent?
   
   YES

10. Rate this solvent's acceptability for cleaning your part?
    
    Highly acceptable................................Acceptable................................................Reject

11. How long did it take you to clean your weapon?
    
    30 min

12. How long did it previously take you to clean your weapon?
    
    30 min

13. What did you previously use to clean your weapon?
    
    C F

REMARKS:
c. Aviation Application

- Skysol 100
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS
TANK ID: ST-013

Date: 9/5 Aug 96
Name: schlebach

Type of Part Cleaned (e.g. wheel bearings): Rotol PVH CABS

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 1
Heavily soiled..........................moderately soiled..........................lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease Oil Dirt Mud Other (Describe) ________________

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 4 3 2 1
excellent.................................good.............................average..............................poor

Remarks (If any): ________________________________

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 3 2 1
fast.................................normal..............................slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES NO

If yes, please explain what kind (e.g. pitting, rust, etc.): ________________________________

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,...etc.)

YES NO

If yes, please explain and list the particular part cleaned: ________________________________

7. Did you observe any residue on the part after using this solvent?

YES NO

8. Did you smell any odor?

YES NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless,...etc.)

9. Did you see any possible flammability problems with using this solvent?

YES NO

10. Rate this solvent's acceptability for cleaning your part?

5 4 3 2 1
Highly acceptable........................Acceptable..............................Reject

REMARKS: ________________________________
Appendix C-2. Typical Data obtained from Fort Hood

- Skysol 100
- Breakthrough
FINAL RESULTS OF SOLVENT EVALUATION  
(FORT HOOD, TX)

INPUT DATES: 1 June 1996 - 30 August 1996

SITES:  
  FHT1: Helicopter Engine Repair Shop, Bldg 6970  
  FHT2: Helicopter Propeller Rotor Repair Shop, Bldg 7012  
  FHT3: Helicopter Weapons Maintenance Shop, Bldg 6975  
  FHT4: Helicopter Generator Repair Shop, Bldg 739

1. USER CATEGORY: What class of material is cleaned by PD-680 solvents?
   
   FHT1: Aircraft Engine Parts  
   FHT2: Aircraft parts / bearings / rotor shafts  
   FHT3: Personal crew weapons, and on-board system weapons for AH-64, AH-1F, and OH-58D helicopters  
   FHT4: Aircraft starters, starter generators, and generators

What is your organization and installation?

   All stations are operated by DYNCORP service personnel under contract to the Fort Hood Directorate of Logistics (DOL), Aviation Maintenance Branch

Please provide name, title, address, and phone number:

   FHT1: Glenn Magnusson, Engine Mechanic #817-287-3252  
   FHT2: Billy Stinson, Prop and Rotor Repairman #817-287-2539  
   FHT3: Jeffrey Baynes, Working Leadman #817-288-3510  
   FHT4: Chuck Crowder, Electrician #817-288-3560

2. EVALUATION OF CURRENT PD-680 SOLVENTS:

What types of PD-680 solvents are you currently using to clean weapons, vehicles, or other equipment?

   FHT1: Type II  
   FHT2: Type II  
   FHT3: Type II  
   FHT4: Type II
Are you currently using other than PD-680 type solvents?

FHT1: No
FHT2: No
FHT3: No
FHT4: Yes, Ecolink

What problems have you experienced with current PD-680 solvents?

FHT1: None
FHT2: It stinks
FHT3: It smells bad, nauseating
FHT4: None

What do you like about current PD-680 solvents?

FHT1: Good cleaning characteristics
FHT2: Evaporates quickly
FHT3: It cleans OK
FHT4: It cleans most things OK

What don't you like about current PD-680 solvents?

FHT1: the odor
FHT2: the fumes cause nausea
FHT3: smells bad
FHT4: it doesn't clean burned on grease very well

What type of PD-680 solvents do you like that fit your application?

FHT1: PD-680 Type II
FHT2: PD-680 Type II works well, but SKYSOL 100 works better
FHT3: none
FHT4: no comment

3. EVALUATING ALTERNATIVE SOLVENTS:

Name of Solvent:

FHT1: BreakThrough
FHT2: Skysol 100
FHT3: Skysol 100
FHT4: BreakThrough
What type of cleaning method did you use to evaluate this solvent?

FHT1: Solvent Tank
FHT2: Brushes and soaking
FHT3: Solvent Tank, soaking and brushes
FHT4: Wet brush rinse

What types of equipment or parts were used to evaluate this solvent?

FHT1: Helicopter engine parts
FHT2: Helicopter parts, bearings, rotors, etc.
FHT3: Personal weapons and helicopter weapon systems
FHT4: Helicopter starters and generators

What is your opinion of the solvency?

FHT1: excellent
FHT2: excellent
FHT3: excellent
FHT4: excellent

What is your rating as to its drying time or how quickly it evaporates?

FHT1: normal
FHT2: too slow
FHT3: normal
FHT4: normal

Did you observe any corrosion forming on surfaces of the cleaned parts due to the solvent?

FHT1: No
FHT2: No
FHT3: No
FHT4: No

Did you observe any compatibility problems between this solvent and parts?

FHT1: No
FHT2: No
FHT3: No
FHT4: No
Did you smell any odor? If so, describe the type and degree:

- FHT1: odorless
- FHT2: yes, orange odor - pleasant
- FHT3: yes, nice orange smell
- FHT4: no

When comparing this solvent to PD-680, which product is better fitted for your application?

- FHT1: either one
- FHT2: Skysol 100
- FHT3: Skysol 100
- FHT4: BreakThrough

Overall, what rating would you give for this solvent?

- FHT1: accept
- FHT2: accept
- FHT3: accept
- FHT4: accept

4. HEALTH AND SAFETY OF ALTERNATIVE PD-680 SOLVENT:

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse affects from use of this alternative PD-680 solvent?

- FHT1: dries skin
- FHT2: no
- FHT3: dries hands
- FHT4: none

Did you have problems in disposing of this alternative PD-680 solvent that you tested?

- FHT1: Haven't disposed of
- FHT2: Haven't disposed of
- FHT3: Haven't disposed of
- FHT4: Haven't disposed of

Did you see any possible flammability problems with using this solvent?

- FHT1: No
- FHT2: No
- FHT3: No
- FHT4: No
5. SPEAK-OUT: Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product:

FHT1: It is an acceptable substitute for PD-680, and we like it better

FHT2: We've changed filters twice, and added solvent once to top off the tank. The solvent is dark and dirty looking, but comes out of the brushes clear. It works just as well as when it was new, so the filter must be working.

FHT3: The station is great — it's big enough to put an entire 50 caliber machine gun in for cleaning, and it cleans great. We would like to see a handle on the lid, and maybe a trip-latch that would allow lowering the lid from either side.

FHT4: The solvent works good, but the best part is the station with the filter. This stuff even cleans off the burned on grease.

INSTALLATION POC COMMENTS:

1. The propeller shop gets the most use out of their station. To date, they are the only ones who have changed filters (twice), and have needed to add solvent to fill up the tank.

2. Most comments were on the washer stations — even though everyone liked the solvents, they love the stations. So much so, that the DOL took it upon themselves to order two additional stations to replace the remaining two old SAFETY-CLEAN stations. So, now they are completely equipped with the new INLAND stations and solvents at the Aviation Maintenance Branch.

3. The note above show the level of dissatisfaction with the SAFETY-CLEAN service. They feel they can do much better on their own, with their new stations, and with the filtration system that they feel will extend the life of their new solvents.

4. In my opinion, this was a completely successful evaluation and proves the usefulness of the new alternative solvents. Even more so, I think it shows that filtration technology can significantly reduce the solvent waste stream. Therefore, I intend to propose a P2 project that will completely convert all of Fort Hood to the new stations over then next few years. Alternative solvents approved by TARDEC will be utilized in the new stations, and the information and project plans will be shared with other installations. Fort Polk has already done an analysis that shows they can save about $100k per year by converting to the new stations and solvents.

R.J. HOLLEY
Science & Technology Advisor
III Corps and Fort Hood
Appendix C-3. Typical Data obtained from Kelly AFB

- Breakthrough
- Actrel 1171L
- Electron 296
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

1. USER CATEGORY

What class of material is cleaned by P-D-680 solvents?
(e.g., weapons, artillery, armored, tactical vehicles, combat
service support, aircrafts, ships, bearings, etc...)


Aircraft Parts

What is your organization and installation?

Unified Fuel Control Section
LD PPB

Please provide your name, title, address and phone number:

RICHARD T. ESCOBEDO  Kelly Air Force Base
Fuel Systems Mechanic  San Antonio, Texas
925-7554

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean
weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

Type II

Are you currently using other than P-D-680 solvents?

Yes

What problems have you experienced with current P-D-680 solvents?

None

What do you like about current P-D-680 solvents?

Does the job, less times...

Attachment
What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

Use to get dirty in a hurry.

3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:

Break-through

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

Paint Brush and wire brush

What types of equipment or parts were used to evaluate this solvent?

Table top vat

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

Excellent.

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

Normal

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

No.
Did you observe any incompatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, ... etc.)

No visible problems.

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ... etc.)

None.

When compared this solvent with P-D-680, which product is better fitted for your applications?

Break-through.

Overall, what rating would you give for this solvent? (accept, or reject)

Accept.

1. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

No.

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

No problems.

Did you see any possible flammability problems with using this solvent?

None.
5. **SPEAK OUT!**

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

Suggestions for improved cleaning would be a solvent where no brushing would be necessary. Just drop it in hand after a few minutes take it out clean.

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY
MOBILITY TECHNOLOGY CENTER - BELVOIR
ATTN AMSTA RBF (MR I RHEE)
10115 Gridely Rd STE 128
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee   Fuels and Lubricants Technology Team
Telephone: (703) 704-1824 or DSN 654-1824
Fax: (703) 704-1822
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

1. USER CATEGORY

What class of material is cleaned by P-D-680 solvents? (e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

MADE FOR MILITARY USE

What is your organization and installation?

UFC Section
LDPAB

Please provide your name, title, address and phone number:

Richard Delan W910-825
1310 348, Kelly AFB, S.A.Tex
972-755-4

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

TYPE 2

Are you currently using other than P-D-680 solvents?

YES

What problems have you experienced with current P-D-680 solvents?

NONE

What do you like about current P-D-680 solvents?

DOES THE JOB
What don't you like about current P-D-680 solvents?

We do like it.

What type of P-D-680 solvents do you like that fit your applications?

None or Hard

3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:

ACTUAL GLASS CLEANER

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

Table Top VAT

What types of equipment or parts were used to evaluate this solvent?

AIRCRAFT PARTS

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

Do not like the oil in the solvent or the smell

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

Slow

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.)

None
Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, ... etc.)

\[ NO \]

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ... etc.)

\[ Yes, Strong \]

When compared this solvent with P-D-680, which product is better fitted for your applications?

\[ P-D-680 \]

Overall, what rating would you give for this solvent? (accept, or reject)

\[ Reject \]

4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

\[ NO \]

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

\[ Still in Use \]

Did you see any possible flammability problems with using this solvent?

\[ NO \]
5. SPEAK OUT!

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

Would not use unless nothing exists around.

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY
MOBILITY TECHNOLOGY CENTER - BELVOIR
ATTN AMSTA RBF (MR I RHEE)
10115 Gridley Rd STE 128
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee  Fuels and Lubricants Technology Team
Telephone: (703) 704-1824 or DSN 654-1824
Fax: (703) 704-1822
SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

1. USER CATEGORY

What class of material is cleaned by P-D-680 solvents?  
(e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

AEROSPACE GROUND EQUIPMENT

What is your organization and installation?

433 MXS/AGE LGME

KELLY AFB

Please provide your name, title, address and phone number:

Steven Fizzini, age mechanic, USAF 
1305 W. VILLA MARIA, APO E103
Bryan, TX 77801

day phone (210) 977-4078

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

Not sure

Are you currently using other than P-D-680 solvents?

Citri-Kleen

What problems have you experienced with current P-D-680 solvents?

None

What do you like about current P-D-680 solvents?

leave little or no film after cleaning
completely removes wet and sticky oil
works pretty well on dry hard oil
3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:  Electron 296

What type of cleaning method(s) did you use to evaluate this solvent? (short description)
  used recirculating type parts washer, for additional effectiveness used
  a soft parts cleaning brush, soaked some parts

What types of equipment or parts were used to evaluate this solvent?
  wheel bearings and related hardware
  Starter

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)
  excellent

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?
  Very good evaporation rate. No noticeable evaporation, but parts
  dried quickly
  * did not dry out while trying to clean

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)
  No undesirable surface effects noted
Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed... etc.)

No, but did not allow soft parts to soak, wipe down resulted in no noted undesirable effects.

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

Very pleasant.

When compared this solvent with P-D-680, which product is better fitted for your applications?

This product worked better than the old solvent we used but I am unsure what the previous product was.

Overall, what rating would you give for this solvent? (accept, or reject)

Accept.

4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

No more than any previously used solvent, less irritating than some solvents (cannot provide list) I have used in the past - both government and commercial.

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

No, but I am not responsible for the actual disposal, only to ensure it is disposed in proper containers and delivered to hazardous waste disposal personnel.

Did you see any possible flammability problems with using this solvent?

None noted.
5. SPEAK OUT!

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

Minor contact did not result in skin irritation.
Washes well with soap and water. Compare this to diesel fuel, where hand-fed skin feels unpleasant and retains odor after repeated washings. New solvent left little or no unpleasant odor or slickness after soap and water washing.

Product did not leave oily film or dry residue after use.

Product did not evaporate too fast to use. Compare this to brake cleaner (such as 1-1-3 trichloroethane) which evaporates so fast as to make it impractical for heavy duty cleaning.

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY
MOBILITY TECHNOLOGY CENTER - BELVOIR
ATTN: AMSTA RFB (MR-I RHEE)
10115 Gridley Rd STE 128
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Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team
Telephone: (703) 704-1824 or DSN 654-1824
Fax: (703) 704-1822
D. Photos taken from Field Demonstrations
Solvent Demonstration at Fort Lewis
Vehicle Maintenance Shops

Parts Used in Solvent Demonstration
Vehicle Maintenance Shops

Corrosion Occurred Due to the Water Based Solvent
Weapon Cleaning Applications
Weapon Cleaning Applications
Aviation Maintenance Shops

An Aviation Part Used in Solvent Demonstration
Solvent Demonstration
at Fort Hood
Helicopter Maintenance Shops

Helicopter Engine Being Cleaned
Helicopter Gun Maintenance Shop

Helicopter Gun Used in Solvent Demonstration

Used Filter Being Cleaned
Aviation Generator Repair Shops

Demonstration of Cleaning Power, Dirty Part, Cleaning Part, Cleaned Part
Solvent Demonstration
at Kelly Air Force Base
Aviation Ground Equipment Shop

Before (left) and After (right) Cleaning
Parts Used at the Aviation Fuel Control Equipment Repair Shop
DISTRIBUTION LIST

DEPARTMENT OF THE ARMY:

CDR AMC
1 ATTN AMCRD E
5001 EISENHOWER AVE
ALEXANDRIA 22333-0001

CDR TACOM
1 ATTN AMSTA TR-O/204
1 ATTN AMSTA TR-R/202 (DR MCCLELLAND)
WARREN MI 48397-5000

50 MOBILITY TECHNOLOGY CENTER BELVOIR
ATTN AMSTA RBF
10115 Gridley RD STE 128
FT BELVOIR VA 22060-5843

CDR ARMY TACOM
1 ATTN AMSTA IM-H
1 ATTN AMSTA IM-GLO
1 ATTN AMSTA IM-J
1 ATTN AMSTA IM-A
1 ATTN USMC LDO
1 ATTN AMSTA IM-G
1 ATTN AMSTA IM-OPITL
1 ATTN AMSTA IM-OEM
WARREN MI 48397-5000

PROGRAM MANAGER
ABRAMS TK SYS
1 ATTN SFAE-ASM-AB
WARREN MI 48397-5000

PROGRAM MANAGER
1 BRADLEY FIGHTING VEH
ATTN SFAE-ASM-BV
WARREN MI 48397-5000
PROGRAM MANAGER
FAM MED TACT VEH
ATTN SFAE-TWV-FMTV
WARREN MI 48397-5000

CDR APC
1  ATTN  SATPC L
1  ATTN  SATPC QE (BLDG 85 3)
   NEW CUMBERLAND
   PA 17070-5005

1  PETROL TEST FAC WEST
   BLDG 247 TRACEY LOC
   DDRW
   P O BOX 96001
   STOCKTON CA 95296-0960

CDR ARMY TECOM
1  ATTN  AMSTE TA R
1  ATTN  AMSTE TC V
1  ATTN  AMSTE EQ
   APG MD 21005-5006

PROJ MGR PETROL WATER LOG
1  ATTN  AMCPM PWL
   4300 GOODFELLOW BLVD
   ST LOUIS MO 63120-1798

PS MAGAZINE DIV
1  ATTN  AMXLS PS
   DIR LOGSA
   REDSTONE ARSENAL
   AL 35898-7466

DIR
   ARMY RSCH LAB
1  ATTN  AMSRL CP PW
   2800 POWDER MILL RD
   ADELPHIA MD 20783-1145
CDR ARMY SSC
1 ATTN AMSSS US (SIEGEL)
1 ATTN AMSSS UE
NATICK MA 01760-5018

CDR ARMY ARDEC
1 ATTN AMSTA-AR-CC
1 ATTN AMSTA-AR-ESC-S
PICATINNY ARSENAL
NJ 07808-5000

CDR ARMY DESCOM
1 ATTN AMSDS MIN
1 ATTN AMSDS EN
CHAMBERSBURG PA 17201-4170

CDR TRADOC
1 ATTN ATCD SL5
INGALLS RD BLDG 163
FT MONROE VA 23651-5194

CDR ARMY FIELD ARTY SCH
1 ATTN ATSF CD
FT SILL OK 73503

CDR ARMY ENGR SCHOOL
1 ATTN ATSE CD
FT LEONARD WOOD
MO 65473-5000

CDR
RED RIVER ARMY DEPOT
1 ATTN SDSRR M
1 ATTN SDSRR Q
TEXARKANA TX 75501-5000

CDR
TOBYHANNA ARMY DEPOT
1 ATTN MR PARRENT
11 MIDWAY ROAD
TOBYHANNA PA 18466-5086

Field Demonstration for P-D-680 Solvent Replacement
CDR
CRANE ARMY AMMUNITION ACTIVITY
1 ATTN SMCCN-EDS (MR THOMAS)
300 HIGHWAY 361
CRANE IN 47522-5099

NATIONAL GUARD OF NEBRASKA
1 USPFO FOR NEBRASKA
1111 MILITARY ROAD
LINCOLN NE 68508-1093

CDR
501ST CORPS SUPPORT GROUP
DEH AREA 1 EAST (CAMP PAGE)
1 ATTN EANC-YG-CP-DEH
UNIT #15002
APO AP 96208-0210

ARMY NATIONAL GUARD OF ARKANSAS
1 ATTN DM-SES (MAJ STANLEY)
NORTH LITTLE ROCK AR 72118-2200

USAF NEBRASKA AIR NATIONAL GUARD
1 155TH AIR REFUELING GROUP (SMS FRERICHS)
2420 WEST BUTLER AVE
LINCOLN NE 68524-1897

ARMY NATIONAL GUARD OF PENNSYLVANIA
1 STATE SURFACE MAINTENANCE OFFICE
BLDG 9-68 FORT INIANTOWN GAP
ANNVILLE PA 17003-5002

CDR
US ARMY ENGINEERING CENTER
AND FORT LEONARD WOOD
1 ATTN ATZT-DL-M (MR BUCKINGHAM)
FORT LEONARD WOOD MO 65473-5000
NEW JERSEY AIR NATIONAL GUARD
1 108TH ARW/LGQ (MSG MILLER)
33-22 FLEBELKORN ROAD
MCGUIRE AFB, NJ 08641-5406

CDR
FORT SAM HOUSTON
1 ATTN AFZG-DL-MO (MR ROGERS)
2107 17TH STREET
FORT SAM HOUSTON TX 78234-5036

ALASKA ARMY NATIONAL GUARD
1 ATTN AKNG-ARL-SMM (MAJ DEWAN)
P.O. BOX 5800
FORT RICHARDSON ALASKA 99505-5800

CDR
4TH SPECIAL OPERATIONS SUPPORT COMMAND
1 ATTN APSO (CPT SEABAUGH)
FORT SHAFTER HAWAII 96858-5435

THE SOUTH DAKOTA ARMY NATIONAL GUARD
1 ATTN SDCLO (LTC SLY)
2823 WEST MAIN STREET
RAPID CITY SOUTH DAKOTA 57702-8186

BRADLY AIR NATIONAL GUARD
1 103 CAM SQUADRON (MR FITZPATRICK)
100 NICHOLSON ROAD
EAST GRANBY CT 06026-5000

CDR
US ARMY ACALA
1 ATTN AMSTA-AC-QAM-S(MR MAAEHR)
ATTN AMSTA-AC-DLD(MR CRAM)
ROCK ISLAND IL 61299-6000

KENTUCKY ARMY NATIONAL GUARD
1 ATTN KG-DOM (MR DUNAWAY)
100 MINUTEMAN PARKWAY
FRANKFORT KY 40601-6168
NEBRASKA ARMY NATIONAL GUARD
AVIATION SUPPORT FACILITY
1 BLDG 624 LMAP (CW3 MCKLEM)
LINCOLN NE 68524-1898

MISSISSIPPI NATIONAL GUARD
MAINTENANCE SHOP
1 MATES BLDG 6800 (MR FARVE)
1 SHOP #1 (MAJ PYLANT)
CAMP SHELBY MS 39407-5500

CDR
10TH DIVISION SUPPORT COMMAND
1 HQ 10TH FORWARD SUPPORT BATTALION (CPT MECCA)
1 HQ E CO 25TH AVIATION (SGT HEAD)
1 HQ B CO MSB (CW2 PHIPPS)
FORT DRUM NY 13602

HQ US ARMY ALASKA
FORT RICHARDSON (MR PENYAK)
1 600 Richardson Drive #5000
Fort Richardson Alaska 99505-5000

OREGON AIR NATIONAL GUARD
1 142 MAS (MR KOHL)
1 142 MAS ANG (MR SMITH)
1 142 MAS SQ/MAFAG (MR. KUTCHER)
1 142 MAS/MAWR (MR. BECKER)
6801 NE CORNFOOT AVE
PORTLAND OR 97218-2797

NEW HAMPSHIRE NATIONAL GUARD
1 US PROP & FISCAL OFFICE
PO BOX 2003
CONCORD NH 03202-2003

IOWA NATIONAL GUARD
1 EMC-C CAMP DODGE (MR SHROYER)
1 GS MAINTENANCE CO (MR DAVIS)
7700 NW BOAVER DR
JOHNSON IA 50131-1902
CDR
G4/DOL MAINTENANCE DIVISION
1 ATTN ATZK DLM
FORT KNOX KENTUCKY 40121

CDR
DG/G5 MAINTENANCE DIVISION
1 ATTN ATZK DLM (MR HAM)
FORT KNOX KENTUCKY 40121

CDR
HQ US ARMY AVIATION & TROOP COMMAND
MAINTENANCE DIRECTORATE
1 ATTN AMSAT-I-MEP (MR SCHICK)
ATTN AMSAT-I-ME (MR HEPLER)
4300 GOODFELLOW BLVD
ST LOUIS MO 63120-1798

PENNSYLVANIA ARMY NATIONAL GUARD
1 AVIATION SUPPORT FACILITY
125 GOODRIDGE LANE
WASHINGTON PA 15301-0020

DELAWARE ARMY NATIONAL GUARD
1 ORGANIZATION MAINTENANCE SHOP #5 (MR BAKER)
RD 2 BOX 214C
DAGSBORO DELAWARE 19939-98021

WASHINGTON ARMY NATIONAL GUARD
1 MILITARY DEPARTMENT (MR DOSLAND)
CAMP MURRAY
TACOMA WASHINGTON 98430-5000

CDR
FLEET ACTIVITIES CHINHAE
1 PSC 479 (MR HENDERSON)
FPO-AP 96269-1100

WISCONSIN ARMY NATIONAL GUARD
1 ATTN WIAR-F (MS NICHOLLS)
PO BOX 14587
MADISON WI 53714-0587
SOUTH DAKOTA AIR NATIONAL GUARD
1 114FG LGQ (MSGT KREULEN)
1201 W ALGONQUIN ST
PO BOX 5044
SIOUX FALLS SD 57117-5044

MASSACHUSETTS AIR NATIONAL GUARD
1 104TH FIGHTER GROUP (SMSGT SANVILLE)
BARNES MUNICIPAL AIRPORT
WESTFIELD MA 01085-1385

ARIZONA ARMY NATIONAL GUARD
1 FACILITIES MANAGEMENT OFFICE (CPT GILMAN)
5636 EAST MCDOWELL ROAD
BUILDING 331
PHOENIX AZ 85008-3495

ARKANSAS AIR NATIONAL GUARD
1 189 AG/MAFA (MR WILLIAMS)
4600 VANDENBERG BLVD
LITTLE ROCK AFB AR 72099-5065

MONTANA ARMY NATIONAL GUARD
1 DIRECT SUPPORT COMBINED MAINTENANCE SHOP (MR SMITH)
PO BOX 4789
HELENA MT 59604-4789

127TH F.W. SELFridge ANGB
1 ATTN MR NOWICKI
MT CLEMENS MI 48045

CDR
1 U.S.Army Environmental Center
Environmental Technology Devison
Attn: Mr. Heffinger
Bldg 440
Abenddeen Proving Grounds, MD 21010-5401
CDR
1 Army Alanta Contracting Center
ATTN: AFLG-PRC (Ms. Williams)
Bldg 130
Anderson way, Ft. McPherson, GA 30330-6000

CDR
1 7th Army Training Command
AMC-FAST Science and Technology Advisor (Mr. Rees)
ATTN: AEAGX-SA, APO AE 09014

CDR
3 Ft. Hood AMC-FAST Science and Technology Advisor (Mr. Holly)
ATTN: AFZF-CS-SA
Bldg 1001 Room C325
Ft. Hood, TX 76544-5056

CDR
1 1 Corps & Fort Lewis
Ft. Lewis AMC-FAST Science and Technology Advisor (Mr. Schiller)
ATTN: AFZH-CSS
MS#1f, Box 339500
Ft. Lewis, WA 98433-9500

CDR
5 1 Corps & Fort Lewis
ATTN: AFZH-DEQ, MS17C (Ms. Trout)
Ft. Lewis, WA 984-5000

DEPARTMENT OF THE NAVY:

CDR
NAVAL RSCH LABORATORY
1 ATTN CODE 6176 (R. MOWERY)
4555 OVERLOOK AVENUE, SW
WASHINGTON DC 20032
CDR
NAVAL SEA SYSTEMS CMD
ATTN SEA 03M3
2531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5160

CDR
NAVAL SURFACE WARFARE CTR
ATTN CODE 632 (MS BIEBERICH)
ATTN CODE 859
3A LEGGETT CIRCLE
ANNAPOLIS MD 21401-5067

CDR
NSWCCD
ATTN CODE 631 (MR LUNDY)
US NAVAL BASE BLDG 619
PHILADELPHIA, PA 19112-5083

CDR
NAVAIR AIR 4.3.4JEM (MR MULLER)
1421 JEFFERSON DAVIS HIGHWAY
ARINGTON, VA 22243

DEPARTMENT OF THE NAVY/U.S. MARINE CORPS:

PROG MGR COMBAT SER SPT
MARINE CORPS SYS CMD
2033 BARNETT AVE STE 315
QUANTICO VA 22134-5080

CDR
MARINE CORPS LOGISTICS BA
ATTN CODE 837
ATTN CODE 883
814 RADFORD BLVD
ALBANY GA 31704
CDR
BLOUNT ISLAND CMD
1 ATTN CODE 922/1
JACKSONVILLE FL 32226-3404

CDR
MARINE CORPS LOGISTICS BA
1 ATTN CODE B880 (MR MSRTEL)
BARSTOW CA 92311-5015

CDR
1 Naval Aviation Depot
Materials Engineering Division
Code 4.3.4.3 (Ms. Grant)
Cherry Point, NC 28533-0021

DEPARTMENT OF AIR FORCE:

AIR FORCE WRIGHT LAB
1 ATTN WL/POSL
1790 LOOP RD N
WRIGHT PATTERSON AFB
OH 45433-7103

AIR FORCE WRIGHT LAB
1 ATTN WL/MLBT
2941 P ST STE 1
WRIGHT PATTERSON AFB
OH 45433-7718

AIR FORCE WRIGHT LAB
1 ATTN WL/MLSE
2179 12TH ST STE 1
WRIGHT PATTERSON AFB
OH 45433-7718
1  WR ALC/LVRS
   225 OCMULGEE CT
   ROBINS AFB
   GA 31098-1647

   SAN ANTONIO AIR LOGISTICS CENTER
2  SA-ALC/TIESM
5  SA-ALC/TIEM (Mr. Baggett)
   450 QUENTION ROOSEVELT ROAD
   KELLY AFB, TX 78241

DEPARTMENT OF DEFENSE:

   DEFENSE SUPPLY Center Richmond
1  ATTN  DSCR SSA
1  ATTN  DSCR STA
2  ATTN  DSCR VBB
   8000 JEFFERSON DAVIS HWY
   RICHMOND VA 23297-5000

12  DEFENSE TECH INFO CTR
   8725 John J. Kingman Rd
    Suite 0944
   Ft. Belvoir VA 22060-6210