# Chapter 5: Compliance Program Costs

The Phase 1 rule is a "certification only" rule in that the standards need only be met at certification prior to production and SEA. This proposed Phase 2 regulation brings the concepts of useful life, emission deterioration, and in-use compliance monitoring to the emission regulation of small spark ignited engines. These program elements work to assure that actual production engines meet standards throughout their useful lives.

The costs accounted for in this chapter are those costs that are above those required in Phase 1. Appendix C contains the detailed cost spreadsheet results for each compliance program. A summary of the cost results for each program per engine class and the overall cost methodology is included at the end of this chapter. Reductions in costs for small volume engine manufacturers or small volume engine families are not accounted for in this analysis.

## 5.1. Background

General assumptions and cost estimates for the various compliance programs for handheld and nonhandheld engines are described herein.

### 5.1.1. Engine Families

Most program costs are calculated on the number of engine families per class and technology group. This data is taken from EPA's Phase 1 certification database. While a reliable source for engine families for the Phase 1 program, EPA expects that manufacturers may make changes during the years in which the Phase 2 program is in effect. However, it is difficult to predict these changes at this time. Consequently, this analysis makes no assumption as to a

different number of engine families from the Phase 1 database.

The EPA Phase 1 certification database is also likely to contain more engine families for Class V, and possibly other classes, in the future because Class V engine families have until January 1, 1998 to certify to the Phase 1 standards. This analysis contains the number of engine families per class as of September 1, 1997 and will be updated for the final rulemaking. The costs associated with record keeping requirements for each program is included in the ICR's submitted with this rulemaking.

### 5.1.2. Alternative Fueled Engine Families

EPA's Phase 1 database shows that there are several engine families of the same engine displacement and technology that are certified on gasoline and alternative fuels (LPG, CNG). Each of these engine families are accounted for in all compliance programs. The alternative fuels often require specific fuel metering systems and run leaner than gasoline, therefore new engine settings and deterioration are likely different among engine families.

### 5.1.3. EPA Phase 1 Database

A summary of the pertinent nonconfidential information to this analysis is contained in the EPA Phase 1 certification database listed in Appendix C. Information includes the engine manufacturer, engine family and HC, NOx and CO emission data per engine family.

### 5.1.4. Assumed Costs

The common costs among programs: hours for break-in, aging, and emission testing are presented in Table 5-01. Note that manufacturers may find less expensive ways to conduct these programs. Possible alternatives include piggy backing on existing durability programs in-house, inexpensive

bench setups in place of dynamometer time, and/or agreements with local lawn care companies to supply engines in exchange for hour accumulation.

Table 5-01

Common Costs Among Compliance Programs

| TOPIC | ESTIMATE | RESOURCE |
|---|---|---|
| Hours for break-in | Class I - 4.4<br>Class II - 4.8<br>Classes III-V - 4.2 | EPA Phase 1 certification database. Some information is confidential. |
| Bench age ($/hour) | $50.00 | Independent test laboratory - confidential |
| Field age ($/hour) | $60.00 | EPA cost estimate |
| Emission test ($) | $300.00 | EPA estimate from "Cost Study for Phase Two Small Engine Emission Regulations", ICF and EF&EE, October 25, 1996 (1) and other confidential industry data. |

### 5.1.5. Averaging, Banking and Trading

Averaging, banking and trading will enable nonhandheld manufacturers to comply with the HC + NOx standard on a sales-weighted average basis. By essentially allowing a manufacturer to produce some engines that exceed the standards when it can generate or obtain offsetting credits from engines that are below the standards, the ABT program will reduce the capital costs of complying with the Phase 2 standards. Manufacturers will be able to distribute capital across engine families to obtain the most cost effective emission reductions, as long as the sales weighted average emissions of all engines meet the emission standards. The optional ABT program adds no costs to the certification process, but does necessitate limited tracking of engines for credit accounting purposes. Related costs are addressed in the certification ICR's for

this program.

While the program for Averaging, Banking and Trading (ABT) is optional for nonhandheld engine manufacturers, this analysis assumes that all nonhandheld engine manufacturers will utilize this option. The analyses also assumes that manufacturers will work to optimize the number of engine families that will need to be improved to meet the emission standards in this proposed rulemaking. Optimization is achieved by choosing those engine families that have high emission rates and high production volumes that will result in influencing the manufacturers' sales weighted average the most.

## 5.2. Certification

The Phase 2 rule continues the fundamental certification program that was begun in Phase 1. The most significant additional component to certification that affects all engines under Phase 2 is the need to predict emissions for an engine family to its full useful life. This is done through the use of a deterioration factor. The deterioration factor is determined in various ways depending on engine class and design, see Table 5-2.

Table 5-2
Manufacturer Options for Deterioration Factor Determination

| Class/Technology | Options | Costs Above Phase 1 (Assumed) |
|---|---|---|
| Classes III-V all technologies | Engineering judgement | None |
| Class I & II SV and Engines with aftertreatment | -field aging or<br><br>-bench aging (after performing field/bench adjustment factor testing out to full useful life) | Field aging or bench age to full useful life (except Class II SV (120 hrs for families being phased-out) - requires one add'l emission test at end of useful life. |
| Class I, OHV<br>Class II, OHV | -assigned df or<br><br>-manufacturer determined df (must determine for entire useful life category) or<br><br>-good engineering judgement for 500 and 1000 useful lives for Class II OHV (between 2001-2004, subject to in-use testing in 2006) | None<br><br>Manufacturer determined df is an option - overlaps with OHV field durability program therefore no add'l costs assumed. |

### 5.2.1. Certification Program Costs

As shown in Table 5-2, some certification options will not require any additional incremental costs above that for Phase 1. These include good engineering judgement, for handheld engines and certain useful life nonhandheld OHV engines, and assigned df for nonhandheld OHV engines. Good engineering judgement could be based upon such things as data from other in-use programs such as engines aged for the field-bench correlation program, a manufacturer's own in-use testing likely done to test the durability

of new engine designs, etc. Since the costs for such data are accounted for in other parts of the compliance program or as technology development costs, no additional cost for certification is estimated for these engines. For the remaining OHV engines, EPA has assumed that all manufacturers will choose the assigned df.

Table 5-2 shows that there are additional certification requirements for nonhandheld engines of SV design or any engine design that utilizes aftertreatment. The engines will be aged on the bench (if the manufacturer has determined a field/bench adjustment factor for its bench data, see 5.4 Field-Bench Adjustment Factor) or field. This analysis assumes that most manufacturers with SV engines will utilize the field/bench adjustment factor and therefore bench age their engines[19]. The costs to be allocated include aging the engine family out to full useful life. This rulemaking contains one flexibility to this requirement for SV Class II 250 hour useful life engines. These engines can be aged to 120 hrs with extrapolation to 250 hours. This flexibility option requires one additional emission test above and beyond the Phase 1 requirements.

**5.2.1.1. Cost Inputs and Methodology--** The number of engine families chosen for the various useful lives was determined through examination of EPA's Phase 1 database and assumptions of each engine manufacturer's market tendencies (see Tables 5-03 and 5-04). For the Class I 66 hour and Class II 250 hour categories, engine manufacturers that sold to the consumer market were assumed to certify their engine families to these hours.

---

[19] The only time it is assumed that a manufacturer will field age is that case in which it is estimated that a useful life category has only one manufacturer. (See 5.4 Bench/Field Adjustment Factor) In this case the field aging will be less costly than fulfilling the Bench/Field program requirements by themselves.

For the Class I 500 and Class II 1000 hour categories, engine manufacturers that sold to the commercial market and/or were related to the automotive industry were assumed to have engine families in these categories, respectively. For those engine manufacturers that were likely to sell to both consumer and commercial, the engine families were assumed to be in the middle categories of 250 and 500 hours for Class I and II respectively.

An analysis of each engine manufacturer's Phase 1 certifications was used to determine the likely number of engine families that will be phased out[20] and those engine families that are likely to be field aged (see 5.4 Bench/Field Adjustment Factor). Table 5-03 contains the estimates used in this analysis.

Costs for the emission test, break-in hours, and bench aging (on a dynamometer) are listed in Table 5-01. A summary of the costs per year (2001-2010+) per class for certification requirements are listed in Table 5-11.

Other Certification Cost assumptions include the following:

1. Handheld Engines
    1. Substantial carryover of certification will occur after the phase-in of the Phase 2 standards.
    2. Steady, small constant number of engine families (15%) to certify beginning in 2005

2. Nonhandheld Engines
    1. All Class I engines will be certified in 2001 with substantial carryover

[20] The average sales weighted emission number for each engine manufacturer was calculated and compared to the emission standard minus a 10% compliance margin. It was assumed that engine manufacturers would improve the engine families that would influence the overall sales weighted emission number the most. Therefore optimizing the overall number of engine families that would be improved. This information is confidential due to the confidential nature of the projected sales for each engine family.

(85%) after that.
2. No new Class II SV's are assumed after initial certification of existing SV due to phase-out of SV design (e.g. 100% carryover of SV certification is assumed).

Table 5-03
Number of Phase 1 Certification Families per Useful Life Category
Assumptions

Nonhandheld

| CLASS | Useful Life (hours) | 66 | 250 | 500 | 1000 |
|---|---|---|---|---|---|
| I - SV | # Mfr's | 2 | 1 | 1 | -- |
| | # Families | 14 | 2 | 2 | -- |
| | Assumed Field Aged | 0 | 1 | 1 | -- |
| II - SV | # Mfr's | -- | 2 | 4 | 1 |
| | # Families | -- | 11 | 13 | 1 |
| | Assumed Phase Out | -- | 10 | na | na |
| | Assumed Field Aged | -- | 0 | 0 | 1 |

OHV engines are assumed to use assigned df and therefore no additional costs are assumed.

Table 5-04
Number of Phase 1 Certification Families per Useful Life Category Assumptions
Handheld

| CLASS | Useful Life (hours) | 50 | 300 |
|---|---|---|---|
| III | # Mfr's | 1 | 1 |
| | # Families | 3 | 1 |
| IV | # Mfr's | 6 | 12 |
| | # Families | 35 | 100 |
| V | # Mfr's | 3 | 7 |
| | # Families | 8 | 14 |

## 5.3. Production Line Testing

### 5.3.1. Rationale for Production Line Testing

The certification process is performed on prototype engines selected to represent an engine family. A certificate of conformity indicates that a manufacturer has demonstrated its ability to design engines that are capable of meeting standards. Production line testing indicates whether a manufacturer is able to translate those designs into actual mass production engines that meet standards.

Manufacturer run Production Line Testing (Cum Sum) is a new program to the EPA requirements for small engines. Therefore all of the costs are allocated to the Phase 2 program. Note that engine manufacturers will be conducting quality audit testing for CARB and therefore will likely utilize the

same data for EPA's PLT program[21]. However, it is likely that manufacturers do not sell all of their product line for use in California and therefore will incur additional costs to test their whole product line. Since the estimated volume per engine family per manufacturer sold in California is unknown, and likely varies amongst engine manufacturers, no costs were subtracted for CARB quality audit testing.

### 5.3.2. Cost Inputs and Methodology

Although PLT is an option for nonhandheld engine manufacturers, EPA has assumed that all engine manufacturers will conduct PLT. PLT is to be conducted on each engine family certified to the standard each year.

For handheld engines, the number of engine families required to be tested during the phase-in years is based on the phase-in requirements of production volume (20%, 40%, 70%, 100%) per class. In predicting the number of engine families that are likely to be certified during each phase-in year, EPA compared the available engine family specific emission data from the EPA Phase 1 certification database to the Phase 2 standard minus a 10% compliance margin. To meet the production quota, EPA assumed that the engine manufacturers will change over the highest volume engine families first. Table 5-05 contains a summary of the assumed number of engine families certified per engine class. Details can be found in Appendix C.

For nonhandheld engines, the program begins in 2001 for all engine families and all must be certified to Phase 2 standards in 2001. The Class II standard is tightened from the years 2001-2005. To meet the decreasing standards, it is assumed that the number of Class II OHV design engine

[21] If the data are from 50 state engine families sold nationwide and if the test engines are appropriately selected and tested.

families will increase and the number of Class II SV design engine families will decrease. This analysis assumes that the overall number of engine families will stay the same as the number for Phase 1 certification (as of Sept 1, 1997). Testing will be performed on 2-30 engines. A value of 7 tests per engine family are assumed for this analysis. PLT is performed on new engines and therefore an initial engine break-in and emission test is required.

The average break-in hours for each engine per class, emission test costs and break-in costs were utilized in this analysis as described in Table 5-01. A summary of the costs per year (2001-2010+) per class for the requirements in this section are listed in Table 5-12.

Table 5-05

Assumed Engine Family Phase-In Per Class Per Year

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| 2001 | 57 | 117 | - | - | - |
| 2002 | 57 | 117 | 1 | 28 | 5 |
| 2003 | 57 | 117 | 2 | 55 | 9 |
| 2004 | 57 | 117 | 3 | 97 | 15 |
| 2005 | 57 | 117 | 4 | 138 | 22 |

PLT performed for each engine family, regardless if same engine certified with various fuel specifications
Number of engine families taken from EPA Phase 1 certification database as of Sept 1, 1997

## 5.4 Field-Bench Adjustment Factor

The field-bench adjustment factor program is the effort through which adjustment factors are developed such that bench aging can be used to

represent field aging. Bench aging is an option for nonhandheld SV engines and engines with aftertreatment during the certification process. For handheld manufacturers, the bench aging is an option used during the in-use testing program.

For both nonhandheld and handheld manufacturers, this analysis assumes that an industry wide cooperative program will be conducted. As used below, technology subgroups are groups of engine families from one or more manufacturers having similar size, application, useful life and emission control equipment.

This analysis assumes this program is initially completed two years prior to the first year of standard implementation (1999 for nonhandheld and 2000 for handheld) and is again repeated two years after the first completion. A third run of the program is assumed at a rate of 25% of the original effort, in 2006 which is the first year after the phase-in has been complete for both handheld and nonhandheld engines.

### 5.4.1. Cost Inputs and Methodology

The regulations state that a minimum of six engines from each technology subgroup shall be aged and tested. Three of these engines must be aged on the bench and three must be aged in the field. For the technology subgroups in this program in which there are three or more manufacturers, this analysis assumes that each manufacturer will contribute testing of at least two engines from one engine family. For those technology subgroups for which there are two or less engine manufacturers, or the case in which a manufacturer does not want to be a part of the industry wide correlation, of which this analysis does not consider, the manufacturers must fulfill the 3 engine family requirements for each technology subgroup for which they need an adjustment factor. This analysis assumes that each manufacturer contributes engines for

two engine families in the case of two manufacturers. In the case of only one manufacturer per technology subgroup, this analysis assumes the engine manufacturer will choose to field age the engine rather than conduct the program by itself in order to minimize costs.

This analysis reduces the final yearly cost estimate for this compliance program by 20% to account for the likelihood that engine manufacturers will use existing in-house durability programs to gather data for this program. In addition, some data has already been colleted as engine manufacturers evaluate the durability of their engine families and will likely be submitted for use in this program.

**5.4.1.1. Nonhandheld Program--** For nonhandheld manufacturers, the EPA Phase 1 certification database shows that there are 4 Class I and 7 Class II engine manufacturers of SV engines (for a total of 7 different manufacturers), see Table B-01. Since the adjustment factor must be determined for each useful life category, then the useful life choice of each manufacturer is a factor in how many engine manufacturers will cover the full range of useful life categories. The allocation of manufacturers to useful life class is explained in 5.2.3.1. Another influencing factor is the major application in which the engines are utilized. EPA currently acknowledges differences based on the test procedures in the Phase 2 rulemaking of generator sets and all other applications. Table 5-06 lists the inputs used in this cost analysis.

Table 5-06
Assumed Participation in Bench/Field Adjustment Factor Program
SV Engines Only

| CLASS | # of Mfr's | Useful Life | Applications (L&G and generator set) | # of Families for Test per Application |
|---|---|---|---|---|
| I | 2 | 66 | 2 | 4 |
| | 1 | 250 | 2 | 3 |
| | 1 | 500 | 2 | 3 |
| II | 2 | 250 | 2 | 4 |
| | 4 | 500 | 2 | 4 |
| | 1 | 1000 | 2 | 3 |

Note: While this analysis is done by class, it could be that cross class technology subgroups would be acceptable, given certain criteria.

Additional assumptions used in this analysis for nonhandheld engines include the following.

1. There are no bench aging costs for OHVs
2. The only technology group is SV, no catalysts are assumed to be required for these standards.
3. Applications are L&G (lawnmower or tractor) and genset

**5.4.1.2. Handheld Program** -- In-use testing is required of all handheld engine families. Engine families are to be aged in the field or on the bench if an adjustment factor is determined (per technology subgroup). It is assumed that all engine manufacturers will utilize the field/bench adjustment program such that they may perform bench aging. EPA's current estimates (using table B-01 and assumptions of useful lives per engine manufacturer) show that there are 7 engine manufacturers that will certify to their engine families to a 50 hour useful life and 14 engine manufacturers that will certify their engine families to a 300 hour useful life (useful lives were assigned by

manufacturer and not engine family). Each engine manufacturer participating in the program will contribute testing of one engine family per technology subgroup for a minimum of 3 engine families per subgroup. EPA expects that deterioration will vary somewhat according to major applications, and has accounted for 3 applications (string trimmer, chainsaw and generator set). Engine technologies accounted for are 2-stroke, 2-stroke with catalyst and 4-stroke. An industry wide program will likely benefit handheld engine manufacturers and is assumed in this cost analysis.

Analysis of the assumed number of engine manufacturers and engine families per class per useful life for the handheld industry is shown in Table 5-07. EPA recognizes that there may be some technology subgroups that cross class lines, this has not been accounted for in this analysis. EPA also recognizes that acquisition of 300 hours on some pieces of equipment, such as a chainsaw, can be very difficult and time consuming, therefore EPA is proposing to allow 300 hour useful life engines to be tested out to only 75% or 225 hours. Lastly, 4 stroke technology has not yet been proven for chainsaw application due to the high speeds required by the chainsaw and therefore 4 strokes are not projected to be used for this application, largely found in Class V. Cost estimates for program inputs are listed in Table 5-1 for field aging, emission test, and bench aging. A summary of the costs per year (2001-2010+) per class for the requirements in this section are listed in Table 5-13.

Table 5-07
Field-Bench Adjustment Factor Assumptions
No Cross Class Technology Subgroups Assumed

| Class | Technology | # of Mfr's | Useful Life | Applications (trimmer, chainsaw, generator set) | Min # of Families for Test per Application |
|---|---|---|---|---|---|
| IV | 2-stroke | 6 | 50 | 3 | 6 |
| | 2-stroke | 12 | 300 | 3 | 13 |
| | 4 stroke | 2 | 300 | 2 (not chainsaw) | 4 |
| | 2 stroke w/ cat or other | 2 | 50 | 3 | 4 |
| | 2 stroke w/ cat or other | 2 | 300 | 3 | 4 |
| V | 2-stroke | 3 | 50 | 3 | 3 |
| | 2-stroke | 7 | 300 | 3 | 7 |

### 5.4.2. Existing Field-Bench Data

Both the nonhandheld and handheld industries have supplied EPA with data on engines aged in the field and on the bench. This discussion acknowledges the data and relates that data to future testing for this program.

**5.4.2.1. Nonhandheld Engines --** The nonhandheld engine manufacturers have submitted confidential data to EPA on engines that have been aged on the bench and in accelerated programs in the field[22]. Data available to compare field-bench aging on the same engine family were

[22] Not all engine manufacturers were represented nor were their equal amounts of representative test data amongst the engine manufacturers in the confidential database.

available on only a few engine families from one engine manufacturer.

**5.4.2.2. Handheld Engines --** Handheld manufacturers have submitted bench and accelerated field aged engine data to EPA for the Phase 1 rulemaking. The data is presented in Table C-12 of the Phase 1 Regulatory Support Document (ref) and is summarized in the Table 5-08. The data in Table 5-08 is from Class IV engines, whose emissions meet Phase 1 levels, aged to 50 hours and is from the wide open throttle (WOT) mode of the two mode test (WOT and idle). While two Class V engines were included in the testing, the results are not included for the field portion had not been completed and therefore a df calculation could not be made.

The field-bench adjustment program for the Phase 2 proposed rulemaking will include a larger number of engine manufacturers and engine families than those shown in Table 5-08. This is because each manufacturer must be involved in the determination of the bench/field adjustment factor in order to be allowed to use the data. The EPA Phase 1 certification database shows that there are 2 Class III manufacturers, 19 Class IV manufacturers and 13 Class V manufacturers (to date) for a total of 21 different manufacturers. With each manufacturer required to submit at least one engine per engine technology subgroup per class, the total number of engines included in the program will be much more than the number shown in Table 5-09, see Table 5-07, and it will be on Phase 2 engine designs.

Table 5-08
Bench and Field Aged Class IV Engines (0 and 50 hours)
HC+NOx (g/kWh)

| Application | Hours | HC+NOx (field) | HC+NOx (bench) |
|---|---|---|---|
| 30.1cc Chainsaw | 0 | 182.38 | 176.71 |
| | 50 | 182.16 | 174.63 |
| | *df* | 1.00 | *0.99* |
| 38cc Chainsaw | 0 | 214.15 | 212.03 |
| | 50 | 247.71 | 256.72 |
| | *df* | *1.16* | *1.21* |
| 25cc Trimmer | 0 | 168.44 | 168.71 |
| | 50 | 230.26 | 187.33 |
| | *df* | *1.37* | *1.11* |
| 21cc Trimmer | 0 | 201.64 | 206.51 |
| | 50 | 134.99 | 165.23 |
| | *df* | *0.67* | *0.80* |
| 24cc Blower | 0 | 345.81 | 409.26 |
| | 50 | 362.00 | 366.15 |
| | *df* | *1.05* | *0.89* |

Note: engines that show a df >1.0 will be rounded to 1.0 for use in the adjustment factor calculation.

## 5.5. In-Use Testing

### 5.5.1. Rationale for In-Use Testing

As previously indicated, the Phase 2 program differs from the Phase 1 program in that the Phase 2 standards are "useful life" standards, i.e. the

engines are expected to comply for their full useful lives rather than just when new. The in-use Phase 2 testing program is designed to evaluate the emissions of engines in their regulatory useful life to determine whether they do in fact comply.

### 5.5.2. In-Use Testing of Nonhandheld Engines

Engine manufacturers have a choice of utilizing an assigned deterioration factor for OHV engines or determining their own deterioration factor for their full product line within a useful life category[23]. The in-use program proposed for OHV engines serves mainly to evaluate whether the deterioration factors used to certify these engines are valid. DFs will be evaluated by emission testing actual field aged engines[24]. The remaining nonhandheld side valve engines or nonhandheld engines with aftertreatment will be subject to a full useful life certification process where they will be aged in field usage or on an approved bench aging cycle to their full useful life as a requirement for certification. No other in-use emission verification is proposed for these engines.

**5.5.2.1. Cost Inputs and Methodology** -- While EPA did not set standards or guidelines on the number of engines or families that should be

---

[23] The requirements for engine families with manufacturer determined df's are the same as the requirements in this field aging program for OHV engines and therefore all engine families are included in this program for the purposes of this cost analysis. No extra costs are assumed for manufacturers that perform the manufacturer determined df and then are included in the in-use field aging program for OHV engines.

[24] This will necessitate the testing of much smaller quantities of engines than would an annual in-use testing program, while still providing substantial quantities of real in-use engine data. If the resulting test data indicates that certification dfs are too low, EPA may initiate a rulemaking to adjust the program.

tested, this analysis assumes that the program will run with all eligible OHV families from Classes I and II. Those SV engine families that are assumed converted to OHV during the phase-in were also included (see Table 5-09)[25]. Three engines per OHV engine family are to be tested. The total number of engines per manufacturer were then compared to the value of 24 per year, a maximum cap on field age testing per year[26]. The resultant total engine families per year are listed in Table 5-09[27]. As can be seen in Table 5-09, most engine manufacturers are assumed to be completed with the first run of this program after the first year.

---

25 For Class II OHV engines, EPA determined the number of OHV families that were likely to be in production or come into production during the years of the phase-in. This was determined by comparing the sales weighted average emission rate for each engine manufacturer as the average emission standard decreases from the years 2001-2005 (with a 10% compliance margin). As the average emission rate decreases below the engine manufacturer's emission rate, then another SV engine was assumed to be converted to OHV or an OHV was improved, depending on the engine family that would influence the engine manufacturers sales weighted average the most. This likely slightly overestimates the number of OHV engine families that will be produced since it is likely that some engine manufacturers will produce more of existing OHV engine families in place of the SV.

26 Also, EPA expects that the maximum testing may be required in the initial years of the program. Manufacturers would have the option to field test more engines than required by EPA to provide back-ups in case of engine or equipment failures. EPA is also proposing that EPA would have the option to reduce the testing burden as appropriate in subsequent years.

27 The field/bench adjustment factor and engine certification programs also require that engines be field aged. The effect of the number of engine families per manufacturer for these programs is assumed to be limited. As a result, the phase-in schedule presented in the table may change slightly when actually performed.

Table 5-09
Total OHV Engine Families for OHV Field Aging
First Iteration

| | New OHV Families Assumed | Total OHV Families | # Engine Mfr's |
|---|---|---|---|
| 2001 | 2 | 102 | 19 |
| 2002 | 0 | 29 | 6 |
| 2003 | 2 | 2 | 3 |
| 2004 | 6 | 6 | 4 |
| 2005 | 5 | 5 | 3 |

The in-use program for field aging of OHV engines is an ongoing program. The first run of this program includes all engine families and costs (break-in hours, initial emission test, field aging and end emission test, see Table 5-1) are allocated in the year that the OHV engine families were certified. The second run of this program is costed at 50% of the original cost (assuming major carryover of engine families from the first time). Starting in 2010, the program is assumed to be performed every other year at an effort of 10% of the total engine families with one engine tested per engine family.

As with the field/bench adjustment factor program, yearly total costs have been reduced by 20% based on the likelihood that manufacturers will use existing in-house durability programs to gather data for this program. In addition, some data has already been colleted as engine manufacturers evaluate the durability of their engine families and will likely be submitted for use in this program. A summary of the costs per year (2001-2010+) per class for the requirements in this section is listed in Table 5-14.

**5.5.2.2. Timing and Field Age Engine Cap** -- EPA is proposing the

Agency would not require any field testing for the OHV Field Durability Program such that, when added to the field testing a manufacturer may elect to perform for the optional certification df generation or for the field/bench adjustment program, would cause the manufacturer to emission test more than 24 total engines that were field aged to their full useful life. As a result, the estimates presented in Table 5-09 will likely change slightly.

### 5.5.3. In-Use Testing of Handheld Engines

The proposed program for handheld engines is very similar to that promulgated in 40 CFR Part 91 for marine engines. Manufacturers will test a proportion of their engine families each year. EPA will identify up to 25% of a manufacturer's families for in-use testing each year. The engine manufacturer will select a sample of engines and then accumulate hours on the engines to their full regulatory useful lives. A minimum of four engines per family will be tested (two for small families or small manufacturers). If emission failures occur, more engines will be added to the sample up to a maximum of ten. Hours may be accumulated in actual field usage or the engines may be "bench aged" on dynamometers using an aging cycle which has been shown to correlate with field aging.

**5.5.3.1. Cost Inputs and Methodology** -- For this analysis it is assumed that EPA will identify 25% of the certified engines for in-use testing beginning in the first year of the phase-in. The number of engine families on which the 25% is based is determined by the methodology set forth in 5.3.2. Cost Inputs and Methodology for the PLT program, see Table 5-10.

Table 5-10
The Number of Engine Families Assumed Tested In-Use
During Each Phase-in Year and Beyond

| | III | IV | V |
|---|---|---|---|
| 2002 | - | 7 | 1 |
| 2003 | - | 14 | 2 |
| 2004 | 1 | 24 | 4 |
| 2005+ | 1 | 35 | 6 |
| TOTAL during Phase-in | 2 | 80 | 13 |
| TOTAL Phase 1 engine families | 4 | 138 | 22 |

Costs for this program are listed in Table 5-01 for bench aging and emission tests. Based on the current data, 25% of all handheld manufacturer's engine families during the phase-in years will not achieve in-use testing of every engine family. There will still be approximately 40% of the engine families untested after the first four years. Based on current data, it will take an additional two years for all engines to be tested. The testing is continuous and EPA has assumed that the testing will repeat, once all engine families are tested, with one engine per family instead of four (or two) since there will already be a history of data from the engine families and considerable carryover is expected. After the second repetition, then it is assumed that the effort will be only 10% of the allowable engine families with one engine tested per engine family. A summary of the costs per year (2001-2010+) per class for the requirements in this section are listed in Table 5-14.

Additional assumptions for this handheld program

1. 25% of engine families will be bench aged to full useful life and

tested each and every year during phase-in of engine families and beyond.

2. A minimum of 4 engines need be tested per family. For carryover families after the first 4 years, only one engine need be tested. (Analysis shows that it will take 6 years for every family to be included in the program. The one engine/family begins in year 7 (2008)).
3. While manufacturers can choose field or bench aging, it is assumed manufacturers will bench age the engines.
4. Objective is to assure that engines are below the standard, therefore no new engine emission test is required. Only one emission test per engine.

## 5.6 Summary Tables

### 5.6.1. Cost Methodology

The costs for each program were estimated in 1997. A 4% inflation rate is included for each year to apply 1997 costs to future years[28]. Tables 5-11 to 5-14 present the estimated costs per compliance program as incurred through 2010 (see Appendix C for complete analysis to 2026 in the form of recovered costs). The total estimated compliance program costs are presented in Table 5-15. The administrative costs for these programs are included in the ICR's for this proposed rulemaking.

Chapter 7 determines the uniform annualized cost and cost per engine for this rulemaking (with costs as recovered). For the analysis in Chapter 7 all compliance program costs are treated as variable costs.

[28] Based on an average of the percentage change in consumer prices from 1984-1993. (Source: Statistical Abstract of the United States 1994, September 1994 from the U.S. Department of Commerce)

Table 5-11
Resultant Fixed Certification Costs Per Class Per Year
As Incurred, With Inflation

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| 2000 | $186,958 | $574,396 | $0 | $0 | $0 |
| 2001 | $0 | $0 | $0 | $0 | $0 |
| 2002 | $21,431 | $0 | $0 | $0 | $0 |
| 2003 | $0 | $0 | $0 | $0 | $0 |
| 2004 | $23,179 | $0 | $0 | $0 | $0 |
| 2005 | $0 | $0 | $0 | $0 | $0 |
| 2006 | $25,070 | $0 | $0 | $0 | $0 |
| 2007 | $0 | $0 | $0 | $0 | $0 |
| 2008 | $27,117 | $0 | $0 | $0 | $0 |
| 2009 | $0 | $0 | $0 | $0 | $0 |
| 2010 | $29,330 | $0 | $0 | $0 | $0 |

NOTE: Incremental certification compliance program costs, over Phase 1, are $0 for most classes and engine families.

Table 5-12
Resultant Production Line Testing Costs
As Incurred, With Inflation

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| 2000 | $0 | $0 | $0 | $0 | $0 |
| 2001 | $225,697 | $517,400 | $0 | $0 | $0 |
| 2002 | $234,726 | $538,098 | $3,475 | $119,884 | $19,112 |
| 2003 | $244,102 | $559,592 | $7,227 | $249,345 | $39,751 |
| 2004 | $253,863 | $581,970 | $13,154 | $453,804 | $72,346 |
| 2005 | $264,030 | $605,277 | $19,544 | $674,254 | $107,490 |
| 2006 | $274,583 | $629,469 | $20,325 | $701,203 | $111,786 |
| 2007 | $285,560 | $654,633 | $21,137 | $729,235 | $116,255 |
| 2008 | $297,000 | $680,859 | $21,984 | $758,450 | $120,912 |
| 2009 | $308,865 | $708,058 | $22,862 | $788,749 | $125,743 |
| 2010 | $321,231 | $736,407 | $23,778 | $820,328 | $130,777 |

Table 5-13
Resultant Costs for Field-Bench Adjustment Factor Program
As Incurred, With Inflation

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| 1999 | $79,785 | $793,213 | $0 | $0 | $0 |
| 2000 | $0 | $0 | $0 | $1,713,898 | $680,846 |
| 2001 | $86,298 | $857,970 | $0 | $0 | $0 |
| 2002 | $0 | $0 | $0 | $1,853,764 | $736,408 |
| 2003 | $0 | $0 | $0 | $0 | $0 |
| 2004 | $0 | $0 | $0 | $0 | $0 |
| 2005 | $0 | $0 | $0 | $0 | $0 |
| 2006 | $26,248 | $260,951 | $0 | $542,135 | $215,363 |
| 2007 | $0 | $0 | $0 | $0 | $0 |
| 2008 | $0 | $0 | $0 | $0 | $0 |
| 2009 | $0 | $0 | $0 | $0 | $0 |
| 2010 | $0 | $0 | $0 | $0 | $0 |

Table 5-14
Resultant Costs for In-Use Testing Programs
As Incurred, With Inflation

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| 2001 | $1,953,527 | $9,359,949 | $0 | $0 | $0 |
| 2002 | $0 | $3,222,892 | $0 | $381,946 | $71,250 |
| 2003 | $0 | $278,771 | $0 | $794,406 | $87,458 |
| 2004 | $0 | $532,466 | $13,896 | $1,407,276 | $181,910 |
| 2005 | $0 | $305,472 | $14,452 | $2,148,155 | $269,340 |
| 2006 | $1,188,330 | $5,693,655 | $15,030 | $2,234,012 | $280,105 |
| 2007 | $0 | $1,975,889 | $15,631 | $1,638,404 | $291,303 |
| 2008 | $0 | $172,917 | $4,064 | $604,100 | $75,743 |
| 2009 | $0 | $323,914 | $4,227 | $628,232 | $78,769 |
| 2010 | $0 | $185,825 | $4,396 | $653,385 | $81,923 |

Table 5-15
Total Compliance Program Costs Per Class
As Incurred, With Inflation

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| 1999 | $59,947 | $590,467 | $0 | $0 | $0 |
| 2000 | $186,958 | $573,887 | $0 | $1,371,118 | $544,677 |
| 2001 | $2,244,065 | $10,516,021 | $0 | $0 | $0 |
| 2002 | $256,157 | $3,760,990 | $3,475 | $1,984,842 | $679,488 |
| 2003 | $244,102 | $838,362 | $7,227 | $1,043,751 | $127,208 |
| 2004 | $277,042 | $1,114,436 | $27,050 | $1,861,080 | $254,256 |
| 2005 | $264,030 | $910,749 | $33,996 | $2,822,409 | $376,830 |
| 2006 | $1,507,705 | $6,517,376 | $35,355 | $3,368,923 | $564,182 |
| 2007 | $285,560 | $2,630,523 | $36,768 | $2,367,639 | $407,558 |
| 2008 | $324,117 | $853,776 | $26,048 | $1,362,550 | $196,656 |
| 2009 | $308,865 | $1,031,973 | $27,089 | $1,416,981 | $204,512 |
| 2010 | $350,561 | $922,232 | $28,173 | $1,473,713 | $212,700 |

## Chapter 5: References

1. ICF and Engine, Fuel and Emissions Engineering, Incorporated; "Cost Study For Phase Two Small Engine Emission Regulations", Draft Final Report, October 25, 1996, EPA Air Docket A-93-29, Docket Item #II-A-04.