

**IN-SERVICE FAILURES**  
**FROM THE MARINE SURVEYOR'S POINT OF VIEW**  
**AN UPDATE**

Gregory T. Davis, Davis and Company, Ltd.

**ABSTRACT**

The Marine Surveyor's laboratory is the field, and the subjects and the parameters of the examination are rarely defined to the extent afforded in the laboratory. However, with the use of consistent inspection techniques and custom database programs, I present an update to my 1992 paper. The time frame covered in this update is 1988-1995 and the sample base is 5,234 production pleasure craft subjects.

As before, the subjects are categorized into five groups:

1. Operator Error,
2. Manufacturing/Quality Control,
3. Wear and Tear,
4. Osmotic Blisters, and
5. Multi-Problems.

The total sample base exceeds 300% of the original. The percentages within each category remained largely the same. It is concluded that the objective, a means to predicate in-service damage, has been quantitatively demonstrated.

This in-service damage history can be utilized in the preparation of owners manuals, operator training course agenda and to improve product reliability through design.

**INTRODUCTION**

The mechanics in which the survey is completed and the need to maintain the same procedure from project to project was reviewed with the prior paper. It is re-visited with this update, as the system's importance cannot be underemphasized. It is especially important in light of the fact that the resultant data is comprised of twenty individual surveyors' work product results during the subject

time frame, 1988-1995.

The sample base of 5,234 projects represents approximately \$26,000,000.00 in damage presented to insurance companies as claims, to boat manufacturers as warranty claims, or absorbed by boat owners.

#### **THE INSPECTION TECHNIQUE-COLLECTION OF DATA**

The marine surveyor is often hired to perform a condition and value survey for the buyer prior to purchase of a used boat and is also hired by the insurance carrier to investigate the cause and extent of the damage due to the report of an insurance claim.

The investigative process remains the same, primarily comprised of visual inspection with non-destructive testing (NDT) via NOVANEX moisture meter, BARCOL hardness, and air and laminate temperatures recorded electronically. The boat is also tested with the use of a 4 oz ball peen hammer with retorts observed.

Upon completion, the process enables the experienced marine surveyor to be guided toward suspect areas. These areas can then be invasively tested via core samples, removal of parts for laboratory analysis and other destructive testing (ie. Chemical, Scanning Electron Microscope) that our consulting engineers may deem appropriate.

The first line inspection, collection of data process, is always completed by the surveyor and can be very subjective if guidelines are not maintained. The surveyor can be distracted by the concerns of: the buyer as to price, the boat broker as to closing the deal, the insurance company as to the dollar extent of the damage, the verbal rendition/s of the vessel owner and witnesses, his or her own opinion/s, and other factors.

In order to deal effectively with these distractions, an order of inspection process was devised. The process involves the measure of credibility given the data collected. Items of physical evidence are given the greatest measure with descending orders of magnitude given to verbal information from witnesses and disinterested parties, to the least credibility given to statements from interested parties. The surveyor must be guided by the above evaluation process and, before coming to a conclusion or opinion, be drawn to the position that the data supports.

Criteria developed by other organizations is utilized in

data evaluation, such as: Recommended Standards and Practices for Small Boats (1), NFPA 302 (2), Fiberglass Boat Design and Construction (3), Marine Survey Manual for Fiberglass Reinforced Plastic Boats (4) and others.

Once a supported conclusion is determined, the subject is evaluated for the extent of damage or a current market value, depending upon the survey request. In this area the same guidelines apply, in that no unsupported conclusion or opinion can be accepted. A dollar repair figure must be based upon known cost data, either via original manufacturer or OEM, a market value must be supported by comparative listing/sale data from the same model or similar, and a repair cost agreed to by a service facility.

#### **DATA STORAGE/RETRIEVAL- A Relational Database:**

The outlined process ends with a written report rendered to the client. The data and the conclusion from this report are entered into our database reference files. This data can be accessed by manufacturer, model, boat name, HIN, or any of thirty two indices, and then sorted based upon the request. A thirty line synopsis of the conclusion of each survey is included in the reference.

Based upon the collection process guidelines and the method in which the data is stored and retrieved, an accurate history of the survey experience can be garnered.

#### **DATA PRESENTATION**

The survey data was sorted based upon five categories:

1. Operator Error
2. Manufacturer/ Quality Control Problems
3. Wear and Tear
4. Blister Problems
5. Multi-Problems

##### **1. Operator Error**

The largest sample return is operator error (60%), consisting of 3,155 inspections (Table I). These inspections are further broken down into collisions with submerged objects: 1,909; collisions with fixed surface or shore objects and/or other boats: 559; maintenance: 536, and grounding:151. The highest volume is SSO, short for struck submerged object. This damage, again, occurred more frequently in boats 16-24 feet in length operated on inland lakes or rivers. The exception is Lake Erie where larger boats, 24 foot and above, are more frequent. This is largely

due to the shallow depth of the lake and tree debris washed in from rivers during the spring and fall rainy months.

The percentages for each type of operator error, except collisions, is virtually the same as in 1992. The collisions with fixed surface or shore objects went down markedly. I

**Table I**

Category #1 Operator Error		1988-1992		1988-1995	
Collisions		230	26%	559	17%
SSO		448	52%	1,909	61%
Maintenance		132	15%	536	17%
Grounding		58	7%	151	5%

I suspect this is largely due to more stringent enforcement of DWI (driving when impaired) laws and operator knowledge of this enforcement. It is also possible that some formerly collision types were evaluated as SSO's during the period of 1992-1995, and thus explaining the shift of 10% between the two subcategories between the 1992 and 1995 totals.

The remaining subcategories of grounding and maintenance indicate no change from 1992. The conclusion drawn is that the boat operator is not responsive to or is not aware of the responsibilities of boating. These include knowledge of the waters to be boated in, the ability to interpret navigation lights on boats and other aids to navigation, knowing when to quit boating or operational fatigue limits, and knowing how to operate and interpret electronic navigation equipment.

The net result is that there is no real change in Category #1, Operator Error, from 1992 to 1995.

**2. Manufacturer/Quality Control Problems**

**Table II**

Category #2 MFG./QC Problems		1988-1992		1998-1995	
		46	3%	175	3%

not change substantially from those reported in 1992.

This category (Table II), although consisting of a greater number of projects, remains the same in percentile. This likely reflects the consistency of manufacturers overall in maintaining product quality and/or customer service. I would like to think it is the latter, however, the types of projects handled did

The examples include failure of secondary bonds at

bulkheads and stringers, longitudinal cracking in way of strakes and/or stringers with no concurrent collision damage evident, and a lack of backing blocks on load bearing fittings. All of which were reported on in 1992.

Transom failures on outboard powered boats due to moisture deterioration of the plywood was encountered more frequently than before. This is likely due to a more informed boat owner reporting this problem to the manufacturer or insurance company, earlier failure due to higher horsepower outboards, or a combination of the two.

We currently are working on a case of a pedestal seat failure, allegedly due to improper use of fasteners. The circumstances are similar to the one reported on in 1992.

The number of failures occurring on more than one model of any one particular manufacturer has remained about the same.

The conclusion drawn is that because there were no changes in the percentages, that in itself is significant, consequently the types of investigations completed has not changed and thus the state of quality control or production expertise within the industry has not improved from 1992 to 1995.

### 3. Wear and Tear

This category (Table III) is comprised of engine or outdrive related damages, usually presented as an SSO, and fiberglass damage, usually presented as windstorm. The investigation results in their categorization as wear and tear.

Some specific engine related causes are carbonization due to use of inferior 2 cycle oil, pre-detonation damage due to low octane gasoline and/or ignition timing deficiencies, valve seat failure, head gasket failure due to improper reassembly after repair, and others.

**Table III**

Outdrive failures often are determined to be related to a seal failure due to age, improper lubricant level or contaminated lube due to a failure to follow maintenance procedures, and water pump failure due to operation without water or failure to

Category 3  
Wear and Tear

1988-1992		1988-1995	
25	1%	62	1%

follow maintenance procedures.

Fiberglass hull damages are caused by seasonal docking/mooring damage, vented gasoline damage to vinyl accent tape, marine growth damage, canvas deterioration due to the effects of the sun, sailboat rigging failure due to corrosion of fittings, and corrosion of deck fittings and safety gear.

The foregoing could be reduced, to some extent, by providing the boat owner with a comprehensive owners manual and a "help" line.

The actual numbers did not increase appreciably from 1992 to 1995, indicating that the boat owner is getting smarter, is having the dealer or another professional complete service, or is deferring service completely. Some amount of all three plays a part in this category.

#### **4. Category #4 Blister Problems**

The problem of osmotic blisters is not new. It has been addressed by many an author, each with a slightly different perspective, as to how a repair should be effected. These authors', all of them, efforts have not been for naught.

The boat manufacturer has also heard the call, so to speak. When I have visited boat shows and perused the literature, it is common to read about claims relative to blister resistant resin and premium gelcoats used. Inspection of the boats reveals gelcoated bilge spaces, sealed transoms, and sealed limber holes in bulkheads. All in pursuit of a blister resistant boat.

**Table IV**

---

Category #4			
Blister Problems			
1988-1992		1988-1995	
19	1%	35	0%
Blister Projects			
	1992		1995
Wellcraft	3 16%	3	14%
Sea Ray	1 6%	5	14%
Bayliner	3 16%	4	11%
Carver	1 5%	2	6%
Other	11 58%	19	55%

The significant development from the data presented here (Table IV) is the number of projects investigated. Between the 1992 total of 19 and the 1995 total of 35 inclusive, the range is less than two fold. Whereas the sample base is more than three fold in size.

The blister problem is being addressed successfully and this success is at both the repair and manufacturing levels.

---

How is this possible? Communication at the industry level is no doubt partially responsible for educating the surveyor, repairman and boat manufacturer. Litigation has likely also influenced the aforementioned professions.

The communication, at the grass roots level, directed at the boat owner through boating publications was prolific in regard to this problem. It was a topic of great concern among the boating public and one that I was asked to speak about at many United States Power Squadron and yacht club group speaking engagements. The promotional advertising of blister resistant resins and gelcoats by the boat manufacturers, especially in sales literature, reveals the true perversity of the blister problem in that it undermined the confidence of the boating public.

Clearly customer satisfaction is the main engine driving this positive result.

### **5. Multi-Problems**

This group is comprised of five causes, each of which has a more detailed series of subcategories or causes. These projects do not fit into one "simple" cause (Table V). The percentages stayed largely the same for each category, despite the significant increase in project numbers, especially in the fire and weather categories.

The fires ran the gamut from engine electrical due to an owner "repair" to a dynamite houseboat explosion, literally! Some fires were accidental, a carelessly discarded cigarette, and some were not, a forcibly damaged propane fuel tank valve stem leading to a fuel gas explosion. Some related to a manufacturing defect, wiring short circuit, but most did not. Fires in boats, as with other property are influenced by economic conditions. Variable rate boat loans with five year balloon payments were found to have a significant affect on the number of fire occurrences.

**Table V**

Category #5 Multi-Problems			
	1988-1992		1988-
			1995
Fire	77	12%	260
			15%
Sinking	102	15%	341
			18%
Weather	274	43%	814
			46%
Theft	157	25%	319
			17%
Trailer	30	5%	73
			4%

Sinkings were mostly weather related, such as canvas cover blown off in a storm, or a discharged battery due to prolonged bilge pump activity where an owner does not frequent the boat for weeks at a time. Many boat owners do not check their boats for weeks or months at a time, apparently unconcerned that periodic inspection is needed to ensure systems are operational. The weather in the midwest was worse in this reporting cycle than in 1992 with the Mississippi River flood and smaller flood occurrences in Illinois, Wisconsin and Ohio. Some sinkings were intentional, a #2 Phillips head screw driver used as a tool to break the fresh water strainer glass leaves a clear impression in the screen, as an example.

Trailer incidents related to improper load distribution on the trailer after retrieval or forgetting to lash the boat to the trailer. Each of the foregoing led to trailering mishaps including jack knife, loss of the boat from the trailer, and roll over of the tow vehicle and boat and trailer at the outset of the 1 hour trip home. In virtually all instances, the boat was loaded after a full day's cruise accompanied by sun and alcohol consumption by the boat operator, now tow vehicle driver. A fatigued boat operator just does not have the presence of mind to properly load the boat onto the trailer, secure it and then drive home. The percentage is slightly better in 1995 than in 1992 with DWI laws and operator knowledge of these laws likely accounting for the decrease.

The 1995 weather category project number increase was the greatest for any one multi-problem category, so it was broken down into its subcategories (Table VI).

I reported in 1992 that weather at first seems to be uncontrollable from a boat operator's point of view. However, a closer look reveals that this is not true. Although there were two severely rainy summer seasons in the 1992 to 1995 reporting period, the percentage of damage due to windstorm, tornado, flooding and rain remained about the same.

Damage due to freezing increased by 5%, from 15% to 20%. This increase is due, in part, to boat owner attempts to prolong the operating season, early October freeze cycles catching boat owners and marina operators "short" and thus not able to winterize in time, and improper technique when completing the winterization activity.

All weather damages could be reduced if boat operators closely followed forecasted weather summaries. However, popular opinion does not support the accuracy of forecasted weather and, therefore, the boat owner does not generally place much credence in heeding the warnings.

Damage due to lightning increased by almost double, yet weather related damages in total, by percentage, remained about the same as in 1992. These damages included substantial sums paid to replace navigation electronics, interface devices, computers and auto pilots on sailboats.

It is important to note that not a single injury to personnel occurred during the reporting period, even though lightning strikes did occur while boats were occupied and/or operational.

Lightning activity, by number, was highest when a boat was moored afloat in a harbor slip with other boats.

**Table VI**

---

Weather Projects			
	1992	1995	
Windstorm	173	63%	458
			56%
Seiche	4	2%	5
			0%
Tornado	1	0%	5
			1%
Rain	10	4%	15
			2%
Flooding	21	8%	56
			7%
Freezing	41	15%	168
			20%
Lightening	24	8%	107
			14%

---

**Table VII**

---

Lightning Damage By Manufacturer				
	1992		1995	
J Boats	5	21%	5	5%
Catalina	2	8%	7	6%
Beneteau	1	4%	2	2%
Sea Ray	3	12%	7	7%
C&C	1	4%	3	3%

---

Power boats are a significant part of the total number of boats affected by lightning. They are usually in the slip, plugged into shore power, and damage is found most often at the shore power receptacle onboard. If a battery charger is installed, it is usually damaged and the 12 volt systems down line from it are also damaged. The 120 volt systems usually do not suffer significant damage. There may or may not be damage to the boat, or other boats

adjacent. But others also plugged into shore power will usually suffer similar damage.

It is concluded that a power boat's shore power damage is a result of the utility grounding of the neutral conductor and the resultant lightning attraction created. Power surges or transients, along the utility lines, due to lightning also play a role. Attention to these factors by the designer, as is done with aircraft systems, could reduce or eliminate this damage. Consideration by the standards makers, the American Boat and Yacht Council (ABYC) and the National Fire Protection Association (NFPA), of the transient related damage to sensitive 12 volt devices could provide universal remedies to a clearly universal problem (Table VII).

#### **SUMMARY**

The in-service failure history as presented in 1992 was surprisingly accurate considering the small sample base of 1,598 incidents.

The 1995 results, using a sample base three times the size of 1992, indicate that the history is an accurate portrayal of in-service exposures for all pleasure boats from 18-45 feet, as represented in the samples.

In the instance of Category #1, Operator Error, comprising 50% of the reported incidents, it is apparent the history indicates that operator training could reduce the frequency of occurrence. Some suggested methods available include:

1. Operator Training via:
  - a. US Power Squadron

- b. US Coast Guard Auxiliary
- 2. Operation manual/s emphasizing
  - a. Maintenance schedules
- 3. Sales emphasizing to the buyer
  - a. Operational recommendations
  - b. Maintenance recommendations

In Category #5, Multi-Problems, comprising 49% of the incidents, the history indicates that operator education could be utilized to reduce the frequency of accidental fires and make owners aware of the need to frequently inspect their boats to ensure their operational status. The suggested methods to reach the boat owner are the same as related earlier:

- 1. Operator training via:
  - a. US Power Squadron
  - b. US Coast Guard Auxiliary
- 2. Operation manual/s emphasizing
  - a. Fire safety afloat
  - b. Routine maintenance
  - c. Winterization
- 3. Sales emphasizing to the buyer
  - a. Operational recommendations
  - b. Maintenance recommendations

When considering the foregoing and their subcategories, there are potential lessons to be learned and utilized in the design of future boats, especially those exposure areas listed in Table V.

Changes or additions that could be made to the owners manual provided by the boat manufacturer follow the same criteria.

Windstorm, a major number factor, should also be considered in future designs, especially in the subcategory of lightning damages. Freezing should be considered in the operator education/winterization section of the manual and as an agenda item in operator training courses.

### CONCLUSION

The relational data base, married to a consistent inspection technique or data collection and processing system, provides the means to quantify the marine survey experience into a rational in-service life model.

This model can be used to improve customer satisfaction,

improve product reliability, and reduce product liability claims by a proactive boat manufacturer.

This model, in conjunction with customer service data, can assist in establishing a proactive design program, and a proactive operator education program through well designed manuals and dealer education programs.

Public boater education programs, such as are currently available through the US Power Squadron or US Coast Auxiliary, need to specifically address the problems cited herein if a significant change downward in the Operator Error or Multi-Problems categories is to be achieved.

\*\*\*\*\*

## REFERENCES

- (1) American Boat and Yacht Council, Standards and Recommended Practices for Small Craft, 3069 Soloman's Island Road, Edgewater, Maryland, 21037
- (2) The National Fire Protection Association, NFPA 302, Batterymarch Park, Quincy, Massachusetts, 02269
- (3) Scott, Robert J., Fiberglass Boat Design and Construction, John de Graf Inc., Tuckahoe, New York, 1973
- (4) Marine Survey Manual for Fiberglass Reinforced Plastic Boats, Gibbs and Cox, Inc., Marine Engineers and Naval Architects, New York, New York, 1962
- (5) Rockett, T., and Rose, V., "The Causes of Boat Hull Blisters", Department of Chemical Engineering, University of Rhode Island, Kingston, Rhode Island, under USCG grant #1501.83