

# Marine crude oil transport – global voyage losses fall in 2010

*This article by Paul Harrison – Consultant to the HMC-4(A) Marine Oil Transportation Database Committee – presents findings from analysis of 2010 marine crude oil transport data, updating the 2009 analysis which was reported in Petroleum Review in September 2010.*

The Energy Institute (EI) HMC-4A Marine Oil Transportation Database Committee has been collecting and analysing worldwide oil shipping data for over 20 years and meets twice a year. The 2010 autumn meeting was held in Houston in November, and the spring 2011 meeting was held in Milan, hosted by Saras.

Committee members submit their voyage measurement data annually. They receive a global analysis and confidential individual company reports. The main findings from the global analysis are presented below.

## Database growth

The total number of voyages reported in 2010 fell by almost 10%, to just over 10,000, while the number of voyages reported with both bill of lading (BOL) and outturn data also fell. The reported BOL volume totalled 6.22bn barrels – again, a fall of around 10% compared with 2009. The volume of crude with complete data fell to 5.11bn barrels, as shown in **Figure 1**.

The *BP Statistical Review of World Energy* gives global crude seaborne trade for 2009 as 13.7bn barrels, a fall

of about 1.5% compared with 2009. The database therefore includes over 45% of the global volume at BOL and contains complete load and discharge data for 38% of global volume.

## Global losses

Losses have been falling consistently since 2001 and after remaining steady for 2006 and 2007 fell to a net standard volume (NSV) loss of –0.165% in 2008 (by convention losses are given as negative). The 2009 figures showed a slightly greater loss of –0.167%, but losses fell again in 2010 to –0.161%. It must be noted that losses include apparent as well as physical losses. Apparent losses result from the combination of fixed and random errors in the measurement systems used at load and discharge.

The mean NSV loss from the database from 1991 to 2010 is plotted in **Figure 1**. An overall improvement from 1990 to 1995 is clear and global loss then showed no major change between 1995 and 2000. A significant increase in mean NSV loss occurred between 2000 and 2001, but this has been more than reversed over recent years. Although the loss figures appear small, the 0.03% fall in losses between 2000 and 2010 would represent over

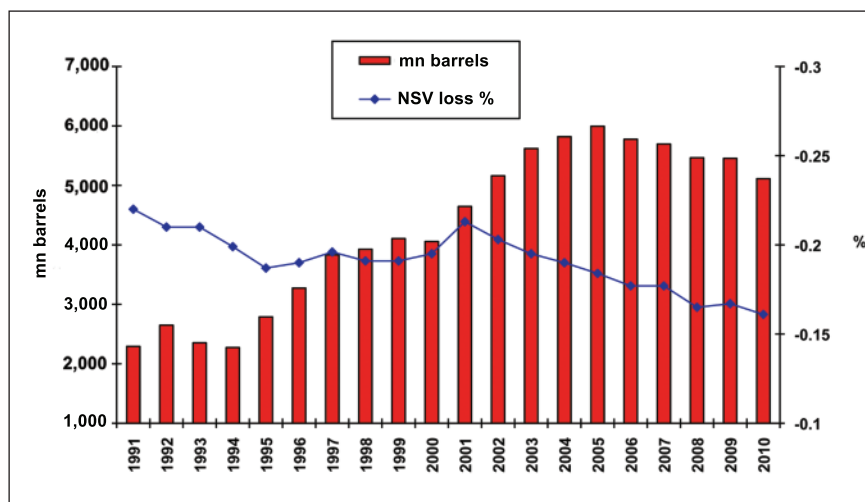
\$400mn at today’s annual global volume and prices.

As shown in **Figure 2**, gross or total calculated volume (TCV) loss fell between 1990 and 1994, but rose again to around –0.15% in 2000. It stayed fairly constant up to 2007, while water losses continued to fall. It was a 0.01% fall in this TCV loss which was responsible for the fall in the NSV loss in 2008, and a further fall to –0.134% which has led to the reduced NSV loss in 2010; water loss having remained constant.

TCV loss comprises any real losses due to evaporation plus any apparent losses due to systematic measurement differences. Water loss represents any additional water reported at discharge compared with that reported at load; ie an accounting loss in terms of oil quantity but not a real loss of either oil or water.

## Loss comparison

**Table 1** gives mean NSV loss and standard deviation for shipments of the most popular crudes in the database (20 or more voyages with full data). The mean of the reported API gravity is also given, together with the overall percentage loss based on reported total barrels shipped. For comparison, figures for NSV loss calculated by



**Figure 1: Growth in volume of database and average net loss of crude oil**

Crude type	API gravity	Overall volumes (NSV)			Calculation by voyage							
		Total barrels	Barrels loss	Barrels loss %	2010			2009				
					NSV loss %	Mean	Std dev	No.	NSV loss %	Mean	Std dev	No.
Abu Safah	29.1	11,703,092	-42,016	-0.36	-0.36	0.13	23	-	-	-	-	-
Agbami	47.9	66,662,270	-160,264	-0.24	-0.24	0.22	69	-0.26	0.24	65	-	-
Akpo	45.7	31,985,182	-15,638	-0.05	-0.04	0.27	33	-	-	-	-	-
Al Shaheen	29.6	41,147,387	-100,805	-0.24	-0.24	0.27	64	-0.21	0.19	55	-	-
Alaskan North Slope	32.0	189,953,091	-125,355	-0.07	-0.08	0.18	224	-0.09	0.20	247	-	-
Alvheim	36.5	28,547,145	-28,885	-0.10	-0.10	0.15	35	-0.17	0.29	41	-	-
Amenam Blend	39.7	31,568,381	-46,340	-0.15	-0.13	0.24	36	-0.05	0.18	38	-	-
Amna	37.5	24,050,759	-71,057	-0.30	-0.30	0.14	42	-0.31	0.19	54	-	-
Arabian Extra Light	39.7	27,693,089	-81,326	-0.29	-0.27	0.26	53	-0.34	0.24	44	-	-
Arabian Heavy	27.8	7,204,591	-14,363	-0.20	-0.17	0.29	21	-0.19	0.34	31	-	-
Arabian Light	33.2	379,303,446	-976,840	-0.26	-0.22	0.26	342	-0.20	0.28	357	-	-
Arabian Light Berri	39.7	23,273,201	-53,643	-0.23	-0.22	0.41	36	-0.07	0.42	36	-	-
Arabian Medium	29.0	17,754,446	-45,467	-0.26	-0.25	0.15	25	-0.15	0.37	55	-	-
Asgard	48.3	43,469,281	-25,805	-0.06	-0.04	0.21	55	-0.12	0.22	68	-	-
Azeri Light	36.0	155,715,859	-157,033	-0.10	-0.10	0.18	238	-0.07	0.21	253	-	-
Banoco Arab Medium	29.1	15,843,115	-23,717	-0.15	-0.14	0.30	29	-0.21	0.28	22	-	-
Basrah Light	30.7	150,800,613	-388,141	-0.26	-0.25	0.29	109	-0.25	0.28	151	-	-
Bonga	30.8	29,308,890	-33,903	-0.12	-0.07	0.37	52	-0.13	0.21	28	-	-
Bonny Light	36.8	36,690,996	-60,425	-0.16	-0.16	0.29	44	-0.30	0.67	34	-	-
Bouri	26.4	12,691,484	-56,388	-0.44	-0.44	0.31	23	-0.37	0.48	41	-	-
Brass	37.1	23,072,757	-33,205	-0.14	-0.19	0.62	31	-0.22	0.32	34	-	-
Brega	41.9	16,963,374	-45,945	-0.27	-0.28	0.22	26	-0.15	0.25	23	-	-
Brent Blend	38.2	45,515,955	-41,125	-0.09	-0.08	0.24	79	-0.11	0.16	69	-	-
Cabinda	32.9	47,112,849	-69,795	-0.15	-0.12	0.17	61	-0.04	0.21	61	-	-
Castilla Blend	18.8	36,631,565	-23,467	-0.06	-0.06	0.22	71	0.03	0.19	54	-	-
Clair	23.6	11,723,026	9,072	0.08	0.11	0.26	72	0.00	0.27	24	-	-
CPC Blend	44.3	114,800,571	-359,274	-0.31	-0.31	0.14	133	-0.30	0.17	155	-	-
Dalia	23.1	24,022,236	-33,468	-0.14	-0.14	0.18	29	-0.23	0.36	46	-	-
Danish	34.2	42,553,736	-47,886	-0.11	-0.11	0.15	69	-0.13	0.26	83	-	-
Djeno	27.7	22,880,033	-39,451	-0.17	-0.17	0.14	26	-	-	-	-	-
Doba Blend	21.2	23,434,227	18,532	0.08	0.06	0.27	26	0.29	0.38	37	-	-
Dolphin Condensate	56.6	15,879,998	-31,362	-0.20	-0.21	0.23	30	-	-	-	-	-
Ekofisk	38.2	82,121,007	-33,032	-0.04	-0.04	0.15	132	-0.06	0.15	184	-	-
El Sharara	42.6	39,079,942	-86,887	-0.22	-0.22	0.17	57	-0.15	0.19	63	-	-
Erha	35.0	37,763,811	-68,014	-0.18	-0.16	0.16	41	-0.08	0.19	37	-	-
Es Sider	36.9	63,098,525	-149,512	-0.24	-0.23	0.20	103	-0.31	0.19	88	-	-
Escravos	33.0	36,743,349	-27,456	-0.07	-0.07	0.19	40	-0.07	0.22	44	-	-
Flotta Mix	36.6	18,791,041	-46,892	-0.25	-0.24	0.24	30	-0.31	0.17	31	-	-
Forcados Blend	30.6	23,885,507	-26,575	-0.11	-0.10	0.38	32	-0.08	0.39	31	-	-
Forties Blend	39.7	104,262,273	-199,184	-0.19	-0.18	0.24	166	-0.15	0.20	195	-	-
Girassol	30.7	29,710,510	-15,520	-0.05	-0.05	0.19	34	-0.09	0.22	65	-	-
Grane	19.0	41,714,761	-1,943	-	0.00	0.20	67	-0.06	0.26	73	-	-
Gullfaks	37.8	43,676,932	-90,920	-0.21	-0.21	0.22	57	-0.24	0.35	100	-	-
Hamaca Blend	21.6	13,424,259	-44,660	-0.33	-0.33	0.32	25	-	-	-	-	-
Hibernia	34.4	26,862,969	-9,017	-0.03	-0.03	0.23	41	-0.06	0.16	34	-	-
Iranian Heavy	29.7	64,273,217	-143,553	-0.22	-0.25	0.37	99	-0.18	0.39	96	-	-
Iranian Light	33.5	68,105,239	-137,752	-0.20	-0.21	0.24	89	-0.17	0.25	74	-	-
Isthmus	32.4	13,878,676	-32,889	-0.24	-0.27	0.19	25	-	-	-	-	-
Kaliningrad	40.3	6,365,935	-17,961	-0.28	-0.28	0.30	51	-0.11	0.43	48	-	-
Karachaganak	49.2	7,594,789	-15,338	-0.20	-0.21	0.29	59	-0.12	0.26	37	-	-
Khafji	28.6	10,888,699	-33,684	-0.31	-0.30	0.10	21	-	-	-	-	-
Kikeh	37.4	22,054,953	-63,920	-0.29	-0.25	0.37	48	-0.31	0.25	37	-	-
Kirkuk	33.2	62,174,284	-85,328	-0.14	-0.14	0.21	98	-0.18	0.24	104	-	-
Kissanje	30.6	22,396,421	-39,507	-0.18	-0.17	0.17	25	-0.21	0.18	26	-	-
Kuwait Export	30.6	69,379,026	-166,830	-0.24	-0.26	0.20	54	-0.24	0.18	57	-	-
Lower Zakum	39.9	19,084,041	-54,767	-0.29	-0.34	0.28	27	-0.26	0.32	33	-	-
Marlim	19.5	24,225,309	-1,795	-0.01	-0.01	0.26	25	-0.07	0.16	24	-	-
Maya	21.0	257,047,467	-420,432	-0.16	-0.17	0.25	470	-0.23	0.26	522	-	-
Mellitah	41.9	31,014,094	-26,565	-0.09	-0.08	0.12	47	-0.08	0.12	33	-	-
Mery 16	16.1	52,583,609	93,703	0.18	0.18	0.18	100	-0.06	0.29	40	-	-
Mudi	37.8	5,423,411	-7,558	-0.14	-0.12	0.30	21	-0.21	0.32	30	-	-
Murban	40.2	62,015,423	-142,480	-0.23	-0.23	0.24	92	-0.28	0.28	92	-	-
Napo	18.5	8,762,591	-4,755	-0.05	-0.06	0.13	24	-	-	-	-	-
Nemba	39.2	31,601,731	-44,249	-0.14	-0.12	0.23	41	-0.15	0.22	56	-	-
N'kossa	38.9	34,279,611	-76,505	-0.22	-0.18	0.45	43	-0.26	0.22	33	-	-
Norne	32.9	14,254,463	-34,767	-0.24	-0.25	0.19	24	-0.19	0.19	28	-	-
Okono	40.9	20,526,537	-52,519	-0.26	-0.22	0.22	27	-0.29	0.26	31	-	-
Olmecca	39.6	59,637,970	-192,366	-0.32	-0.33	0.28	110	-0.38	0.22	82	-	-
Oman Export	31.5	37,666,081	-108,561	-0.29	-0.27	0.34	58	-0.10	0.45	38	-	-
Oriente	23.8	18,833,758	6,456	0.03	0.05	0.37	49	0.16	0.31	48	-	-
Oseberg	37.8	30,020,230	-55,032	-0.18	-0.19	0.15	48	-0.18	0.14	68	-	-
Ostra	23.1	20,779,747	-36,677	-0.18	-0.19	0.30	31	-	-	-	-	-
Plutonio	33.2	17,620,348	-34,387	-0.20	-0.17	0.19	22	-	-	-	-	-
Qua lboe	36.2	58,589,772	-56,700	-0.10	-0.08	0.20	60	-0.11	0.21	43	-	-
Rang Dong	41.0	6,252,443	-24,495	-0.39	-0.36	0.32	31	-0.22	0.47	29	-	-
Ratawi	24.3	10,608,399	-17,245	-0.16	-0.14	0.30	28	-0.18	0.54	37	-	-
Saharan Blend	44.6	55,510,636	-69,970	-0.13	-0.10	0.15	85	-0.07	0.18	115	-	-
Seria Light	35.9	13,534,883	-7,451	-0.06	-0.04	0.35	37	0.00	0.31	41	-	-
Siberian Light	34.6	15,207,282	-36,479	-0.24	-0.23	0.13	28	-0.28	0.11	24	-	-
Sincor Sour	20.3	13,906,164	-36,408	-0.26	-0.25	0.63	29	-	-	-	-	-
Sirri	33.1	35,867,208	-36,466	-0.10	-0.11	0.23	38	-	-	-	-	-
Sirtica	39.7	19,360,272	-16,258	-0.08	-0.08	0.13	32	-0.4	0.16	34	-	-
Souedie	23.4	29,018,964	-73,594	-0.25	-0.24	0.41	57	-0.22	0.25	55	-	-
Statfjord	39.4	45,420,217	-69,024	-0.15	-0.15	0.19	60	-0.16	0.25	76	-	-
Su Tu Den	36.9	14,823,140	-33,252	-0.22	-0.22	0.43	45	-0.38	0.55	64	-	-
Tengiz	46.5	38,796,592	-113,280	-0.29	-0.29	0.16	60	-	-	-	-	-
Terra Nova	33.3	13,785,004	2,216	0.02	0.01	0.09	21	0.00	0.14	23	-	-
Troll	33.8	25,212,831	-8,152	-0.03	-0.03	0.17	41	-0.06	0.17	58	-	-
Upper Zakum	34.3	35,215,441	-92,521	-0.26	-0.27	0.34	57	-0.33	0.25	55	-	-
Urals (Baltic)	31.6	250,828,590	-344,270	-0.14	-0.13	0.12	365	-0.13	0.19	388	-	-
Urals (Black Sea)	30.7	104,109,817	-173,686	-0.17	-0.17	0.16	150	-0.17	0.18	191	-	-
Vasconia	26.7	19,414,060	-26,232	-0.14	-0.14	0.24	38	-0.07	0.17	35	-	-
Western Desert	42.7	7,022,035	-16,866	-0.24	-0.25	0.23	23	-0.38	0.22	23	-	-
YK Blend	33.8	37,064,409	-86,556	-0.23	-0.24	0.29	51	-0.21	0.21	59	-	-
Yoho	39.6	17,787,982	-28,736	-0.16	-0.15	0.22	21	-	-	-	-	-
Zafiro	30.5	20,730,247	-30,469	-0.15	-0.15	0.12	21	-0.15	0.18	43	-	-

Table 1: Analysis by crude oil type, 2010

Crude type	Mean NSV loss %		Table difference
	Original	Corrected	
Abu Safah	-0.36	-0.26	-0.10
Arabian Extra Light	-0.31	-0.17	-0.14
Arabian Heavy	-0.21	-0.17	-0.04
Arabian Light	-0.28	-0.12	-0.16
Arabian Light Berri	-0.22	-0.09	-0.13
Attaka	-0.20	-0.11	-0.09
Azeri Light	-0.25	-0.25	0.00
Banoco Arab Medium	-0.21	-0.08	-0.13
Eocene	-0.08	-0.08	0.00
Hout	-0.32	-0.22	-0.10
Khafji	-0.33	-0.25	-0.08
Khuff Condensate	-0.31	-0.26	-0.05
Kikeh	-0.26	-0.12	-0.14
Lower Zakum	-0.32	-0.18	-0.14
Mudi	-0.20	-0.12	-0.07
Murban	-0.24	-0.09	-0.15
Oman Export	-0.24	-0.09	-0.15
Ostra	-0.24	-0.18	-0.06
Qatar Land	-0.37	-0.29	-0.08
Qatar Marine	-0.21	-0.25	0.04
Ratawi	-0.16	-0.13	-0.03
Souedie	-0.28	-0.26	-0.02
Sumatran Light	0.47	0.56	-0.09
Tapis Blend	0.11	0.16	-0.05
Tengiz	-0.26	-0.23	-0.03
Upper Zakum	-0.29	-0.18	-0.11
Zarzaitine	-0.24	-0.22	-0.03
Zueitina	-0.27	-0.27	-0.02

Mean difference -0.08%

Table 2: Effect of table corrections on net standard volume loss figures for individual crude oils

voyage are given for 2010 and 2009.

Note that the data in Table 1 is not 'table corrected' but based on original BOL figures. Where possible, for load ports using 'old' (1956) Table 6 or Table 54, corrected BOL figures are calculated using 'new' (1980 or 2004) tables for comparison with outturns at discharge ports which also use the 'new' tables. The effect of using table corrected BOL data for specific crudes is shown in Table 2.

It should be noted that as the information in Table 2 is derived from a smaller set of voyages than those used for Table 1 (ie those with both corrected and uncorrected BOL figures) the actual mean losses will therefore differ. Table 1 should be used as a

guide for typical measurement differences and Table 2 gives an indication as to likely table difference. The above figures are based on a minimum of five voyages per grade.

Data for crudes loaded from ports using GOST and DNC tables (FSU and Brazil respectively) were also analysed using load volumes recalculated at source using 'new' tables. However, differences over the year for the grades involved were found to be very small, effectively zero in most cases.

**Detailed loss analysis**

In addition to NSV loss figures, the database contains details of all measurements made through each voyage. This enables

more detailed analysis to determine where losses are occurring and sets realistic performance limits for each stage in the measurement process.

Overall results for each of the main measurement differences are shown in Table 3, comparing figures for 2010 with those for 2009.

Key comparisons used in the analysis are as follows:

- NSV and TCV losses are simple comparisons between BOL and outturn figures.
- NSV is the volume of crude corrected to 60°F with sediment and water quantities (free and dissolved) deducted. TCV is the NSV plus sediment and free and dissolved water.
- Load loss (load difference) is the TCV difference between the received volume measured on the ship (allowing for preload onboard quantity (OBQ)) and the shore delivered volume.
- Discharge loss is the TCV difference between the discharged volume measured on the ship (allowing for remaining onboard (ROB)) and the shore received volume.
- Ship loss or 'transit difference' is the difference between ship TCV measurements at the load port before sailing and at the discharge port on arrival.
- Water loss is the difference between BOL and outturn water and sediment.
- OBQ-ROB difference is the difference between the TCV measured on the ship prior to loading (OBQ) and that remaining after discharge (ROB).

Load and discharge losses have previously been adjusted by applying the vessel experience factor load (VEFL). However, with this factor having become very close to 1.0000 over recent years and with it becoming clear that it should not in any case be applied at discharge, load and discharge losses are no longer adjusted for VEF. However, adjusted losses have been calculated for 2010 for comparison with 2009 and are shown in Table 3. The VEF adjusted load loss remained very close to zero and the use of VEFL at load and discharge essentially 'shifts' any losses at load so that they appear at discharge.

As can be seen, other figures were virtually identical for 2010 as for 2009.

Ship loss shows a small gain, which might not be expected but has been consistent over many years.

The standard deviation of all the key differences decreased for 2010 following a general small increase in 2009.

**Vessel experience factors**

VEFL values have fallen fairly consistently over the past 10 years, as shown in Figure 3. However, the trend has tailed off, with

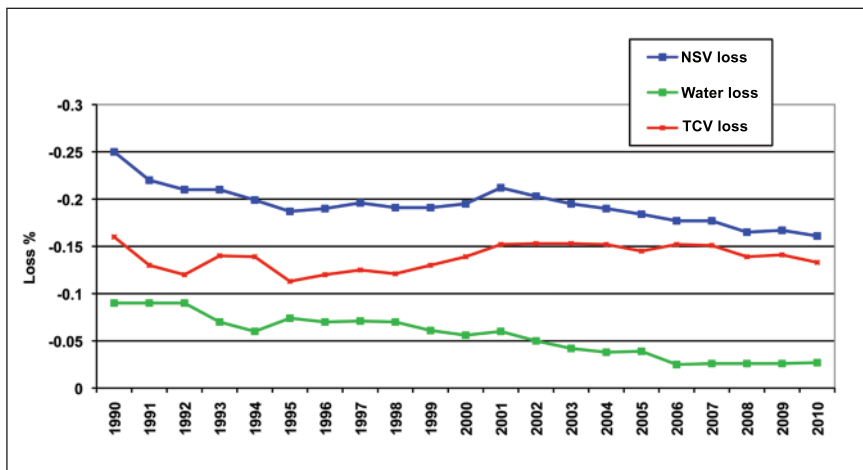


Figure 2: Overall loss trend

the 2010 average by vessel 0.99960 compared with the 2009 figure of 0.99962. The average VEF load by voyage is 0.99965. Both values are below 1.0000 and it would seem that this figure may be close to the real loss at loading. A value of 0.9996 would be equivalent to a -0.04% evaporative loss. However, systematic shore/ship measurement differences will contribute to this figure.

**Conclusion**

Mean NSV loss for 2010 fell to -0.161%, the lowest value since the database work began. The majority of this net shore to shore difference is related to TCV loss and not water loss, and it was a fall in this TCV loss figure which led to the fall in NSV loss. It must be remembered that the TCV loss figure includes not only any real losses between load and discharge port, but also any systematic differences between load and discharge measurements.

Although the number of voyages fell in 2010, the BOL volume in the database represents over 45% of the estimated global total, which also fell slightly compared with 2009.

**Disclaimer**

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	2010		2009	
	Mean	St dev	Mean	St dev
NSV loss %	-0.16 (-0.161)	0.30	-0.17 (-0.167)	0.32
TCV loss %	-0.13	0.28	-0.14	0.31
Load loss %	-0.04	0.26	-	-
Ship loss %	0.02	0.20	0.02	0.22
Discharge loss %	-0.12	0.31	-	-
Water loss %	-0.03	0.16	-0.03	0.18
OBQ-ROB difference %	0.01	0.09	0.01	0.07
VEF adjusted load loss	-0.01	0.23	-0.01	0.24
VEF adjusted disc loss	-0.15	0.29	-0.16	0.32

Table 3: Global loss analysis

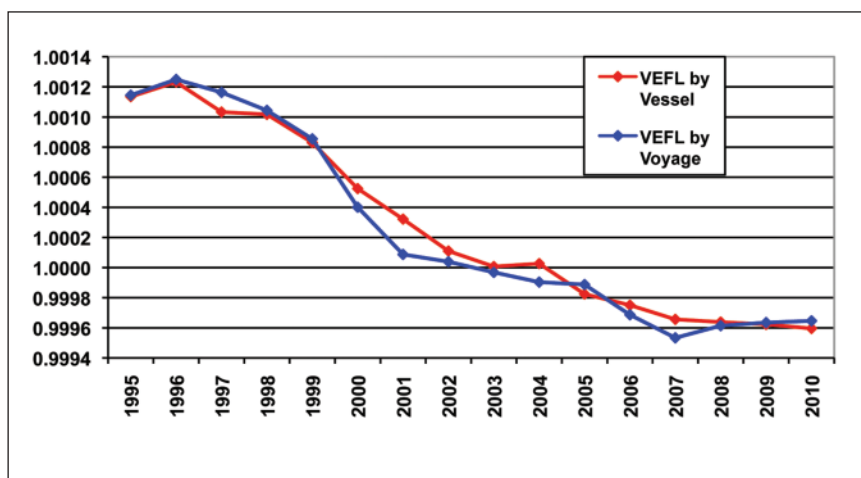


Figure 3: VEF load trend

# Committee aims and membership

The aim of the Committee is to improve loss control through a better understanding of loss patterns and trends. Committee members submit their voyage measurement data for analysis and an annual report is issued individually to all members. This report includes a confidential analysis of the individual company data together with a general global analysis of the entire annual data set. Reports are normally issued in electronic format, but hard copies are provided to members on request.

The following member companies submitted data for 2010: BP Oil International, CEPESA, Chevron, Chinese Petroleum Corporation, ConocoPhillips, Eni, ErgMed, ExxonMobil, Marathon Petroleum, Petrobras, Petrogal (GALP Energia), PMI Pemex, Repsol-YPF, Saras, Shell, Statoil, Sunoco, Total.

The Committee has a target of collecting full load and discharge data for 50% of the crude oil transported by ship. Although existing members are

continuing to provide more data which is complete, it seems clear that to reach this target more members are needed. The Committee is therefore keen to welcome new members and membership is open to all oil companies with data to contribute.

A website has been established for the publication of the information presented here together with additional data concerning crude oil marine transportation. This can be found at [www.oil-transport.info](http://www.oil-transport.info) or via the EI website at [www.energyinst.org](http://www.energyinst.org)

The Committee meets twice a year and meetings are held in conjunction with those of the sister committee, HMC-4B, The Oil Transportation Measurement Committee. The next meetings will be held in Doha, Qatar, on 15-17 November 2011.

HMC-4B is involved with standards development, with close ties to its sister committee in API (COMA), and monitors technical developments in oil transportation measurement. In

addition to work on projects which currently includes the development/update of documents relating to vessel experience factors, inspection company nominations, sampling and marine transportation guidelines, meetings include technical presentations from members and guests to keep members up to date with the latest developments.

Recent publications include *HM 63 Independent inspection company auditing – pre-audit and self assessment information*, which is available for free download together with separate check lists for completion, and a revision to *HM 50 Guidelines for cleaning of tanks and lines for marine vessels carrying petroleum and refined products*, which is also available for free download from the EI website.

Companies interested in joining the committees may be invited to attend as guests and should contact Kerry Sinclair at the EI on t: +44 (0)20 7467 7127 or e: [ksinclair@energyinst.org](mailto:ksinclair@energyinst.org)