Appendix 9.4

Memo on Concrete Weight Coating of Maine Pipeline Protection

Project Memorandum

PCS Project No.	**10045**
Project	**Bakkenlink Pipeline Project**
Aspect	**Lake Sakakawea Crossing**
To	**Jarrett Davis**
From	**Terry Oram**
Subject	**Pipeline Protection**

PCS has extensive experience in developing solutions for the protection of installed marine pipelines. Each project is unique and requires specific design and construction efforts to ensure that the pipeline is installed and operated in a safe manner based on the location and marine traffic plying the waters in the immediate vicinity. For projects in areas of higher than normal marine traffic, the safety of the pipeline under study will be reviewed and evaluated by subject matter experts (SME) in the field of marine engineering and more particularly, the study of anchors and anchor impacts, These studies are intended to develop criteria for pipe wall thicknesses, concrete weight coating density and thickness, depth of pipeline lowering, backfill requirements and in the extreme cases, engineered back-fill or other mechanical protection.

One such study involved the physical evaluation of a range (in weight/size) of anchors being dropped onto a pipeline with varied protective covering to confirm that the planned pipeline was adequately designed and the lowering and protective cover provided 100% protection. In this case a 24-inch pipeline (0.576-inch wall, X-60 with 3.35 inches of 190 pcf concrete weight coat (CWC)) was positioned on land and subjected to 2.5, 4, 7, 9, and 12.5 ton anchors being dropped on the pipeline from a crane. It was found that the concrete coated pipe was able to withstand a direct hit from up to a 4 ton anchor without any permanent dent or deformation of the steel pipe. In all test cases, including the dropping of the anchors directly on the bare girth weld, the pressurized pipe did not fail and in the case of the 2.5 ton (5000 pound) anchor, the CWC was only slightly damaged.

Our understanding of the marine traffic plying Lake Sakakawea in the area of the proposed pipeline crossing is that the boat sizes are generally less than 30 feet LOA including salmon fishing using downrigger equipment. It is assumed that with the presence of multiple existing pipelines crossing in the immediate vicinity of the proposed pipeline route and the direction from the USACE for our pipeline to be routed in this same general area as the existing pipelines, that no dredging or capital works will be performed in this area by the USACE. This being the case, protection of the pipeline will be developed for inadvertent or deliberate anchor drops from 30 feet LOA boats and impacts from downrigger equipment.

The attached *Anchor Selection and Specifications Guide* from Fortress Marine Anchors identifies that 30 feet LOA boat would not use any type of anchor weighing more than 30 pounds confirming a boaters rule of thumb of I pound per I foot of length. The downrigger system uses a 10-20 pound weight to keep the gear at a preferred depth in the water column. If the weight is lowered to the bottom during trawling, it would not damage the lowered pipeline.

Based on these conditions, PCS is satisfied that with the pipeline as designed, as concrete weight coated and lowered with the top of pipe below the natural lake bed, will be adequately protected and safe for operation.

FORTRESS MARINE ANCHORS

NOT JUST STRONGER, LIGHTER!

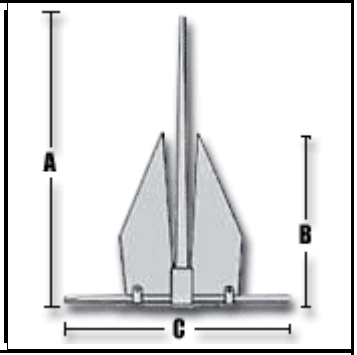
Fortress Marine Anchors
1386 West McNab Road
Fort Lauderdale, Florida, USA 33309

Anchor Selection & Specifications Guide

Boat size recommendations are for boats of average windage and proportions in 30 knots of wind, average bottom conditions, and moderate protection from open seas. Remember that the loads in 42 knots of wind are twice as much as in 30 knots.

Use three-strand nylon rope, 6-12 ft (2-4 m) of chain and a minimum of 5:1 scope. Also, a minimum of 6 ft (2 m) of chain should be used for every 25 ft (8 m) of water depth. For storm conditions use an anchor one or two sizes larger.

Exclusively on Fortress...



FORTRESS SELECTION GUIDE

Model		FX-7	FX-11	FX-16	FX-23	FX-37	FX-55	FX-85	FX-125
Boat Length	ft	16'-27	28'-32	33'-38	39'-45	46'-51	52'-58	59'-68	69'-150
	m	5-8	8-10	10-12	12-14	14-15	16-18	18-21	21-46
Weight	lb	4	7	10	15	21	32	47	69
	kg	1.8	3.2	4.5	6.8	9.5	14.4	21.2	31.1
Replaces Steel Anchors	lb	6-9	10-13	14-18	19-28	33-50	50-65	70-90	100-170
	kg	3-4	5-6	6-8	9-13	15-23	23-29	32-41	45-77

HOLDING POWER

Model	FX-7	FX-11	FX-16	FX-23	FX-37	FX-55	FX-85	FX-125

Working Load	lb	700	900	1.250	2,000	3,000	4,000	5,250	6,750
	kg	318	408	567	907	1,351	1,814	2,381	3,062
32 Degree Hard Sand Holding Power	lb	2,800	3,600	5,000	8,000	12,000	16,000	21,000	27,000
	kg	1,270	1,633	2,268	3,629	5,443	7,258	9,536	12,247
45 Degree Soft Mud Holding Power	lb	840	1,080	1,500	2,400	3,600	4,800	6,300	8,100
	kg	381	490	680	1,089	1,633	2,177	2,858	3,674
32 Degree Soft Mud Holding Power	lb	420	540	750	1,200	1,800	2,400	3,150	4,050
	kg	191	245	340	544	816	1,089	1,429	1,837

DIMENSIONS

Model		FX-7	FX-11	FX-16	FX-23	FX-37	FX-55	FX-85	FX-125
"A" Shank Length [diagram]	in	24"	27"	31"	36"	40"	46"	51"	56"
	mm	610	685	787	914	1,016	1,168	1,295	1,422
"B" Fluke Length [diagram]	in	14"	16"	18"	21"	24"	27"	30"	33"
	mm	356	406	457	533	610	686	762	838
"C" Stock Length [diagram]	in	19"	22"	25"	29"	32"	37"	41"	45"
	mm	483	559	635	737	813	940	1,041	1,143

SUPPORT HARDWARE

Model		FX-7	FX-11	FX-16	FX-23	FX-37	FX-55	FX-85	FX-125
Proof Coil Chain	in	3/16"	1/4"	5/16"	3/8"	3/8"	1/2"	1/2"	1/2"
	mm	5	6	8	9	9	13	13	13
Nylon Rope**	in	3/8"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
	mm	9	9	13	16	19	22	25	32
Shackle Size	in	1/4"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	5/8"
	mm	6	6	8	10	12	12	16	16

NOTE: Hard sand holding power figures above represent loads actually achieved on production FORTRESS and Guardian anchors under controlled horizontal pull conditions without dragging or resulting in disabling structural deformation.

** Rope recommendations are based on 25% of breaking strength. Rope must be in good condition.