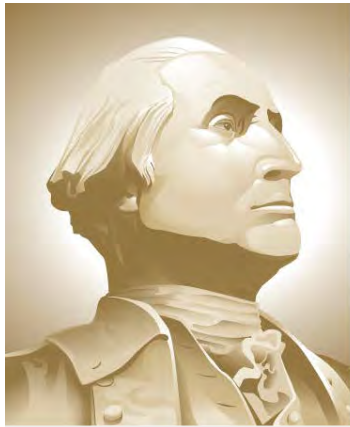


VTRA 2010 POTENTIAL COLLISION OIL FUEL AND CARGO LOSSES BY ALL FV, CARGO – FV, TANK- FV AND WHAT-IF FV

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WASHINGTON, DC

VCU

CASE S: Delta Port 415 + Bunkering Operations

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

AUGUST 31, 2013

PRELIMINARY

Table. Focus Vessel (FV) Classification for the 26 VTOSS vessel type classification used in the GW/VCU MTS simulation model.

- NON – FV** : Those vessels that Interacting Vessels (IV) with Focus Vessels (FV)
- BASE CASE CARGO – FV** : Bulk Carriers, Container Vessels, Other Cargo Vessels that travel in VTRA 2010 Base Case
- BASE CASE TANK – FV** : Oil Barge, Oil Tankers, Chemical Carrier, ATB 's that travel in VTRA 2010 Base Case
- WHAT IF – FV** : CARGO AND TANK FV'S added to VTRA 2010 Base Case to model What-If Scenario

Note: Focus Vessels (FV's) are also considered as Interacting Vessels (IV's) when interacting with another Focus Vessel.

#	VESSEL TYPE	FOCUS VESSEL?	#	VESSEL TYPE	FOCUS VESSEL?
1	BULKCARRIER	CARGO - FV	14	PASSENGERSHIP	NO
2	CHEMICALCARRIER	TANK - FV	15	REFRIGERATEDCARGO	CARGO-FV
3	CONTAINERSHIP	CARGO - FV	16	RESEARCHSHIP	NO
4	DECKSHIPCARGO	CARGO - FV	17	ROROCARGOSHIP	CARGO-FV
5	FERRY	NO	18	ROROCARGOCONTSHIP	CARGO-FV
6	FERRYNONLOCAL	NO	19	SUPPLYOFFSHORE	NO
7	FISHINGFACTORY	NO	20	TUGTOWBARGE	NO
8	FISHINGVESSEL	NO	21	UNKNOWN	NO
9	LIQGASCARRIER	TANK - FV	22	USCOASTGUARD	NO
10	NAVYVESSEL	NO	23	VEHICLECARRIER	CARGO-FV
11	OILTANKER	TANK - FV	24	YACHT	NO
12	OTHERSPECIALCARGO	CARGO - FV	25	ATB	TANK - FV
13	OTHERSPECIFCSERV	NO	26	OIL BARGE	TANK - FV

IMPORTANT:

THE OPERATIVE WORD IN PRESENTING THESE ANALYSIS RESULTS IS THE USE OF THE WORD

POTENTIAL

TO INDICATE THAT THESE ANALYSIS RESULTS DO NOT FOLLOW FROM AN HISTORICAL DATA ANALYSIS, BUT THROUGH THE USE OF AN ANALYSIS TOOL THAT EVALUATES SUCH **POTENTIAL**.

THE 2010 YEAR IS CONSIDERED **THE BASE CASE YEAR** AND A BASE CASE YEAR POTENTIAL IS EVALUATED.

NEXT, **WHAT-IF SCENARIOS** ARE DEVELOPED FROM THE BASE CASE BY ADDING ADDITIONAL HYPOTHETICAL TRAFFIC AND A WHAT-IF POTENTIAL IS EVALUATED AND COMPARED **RELATIVE TO THE BASE CASE** TO INFORM **RISK MANAGEMENT**.

CASE S: DP 415 + Bunkering Operations:

BASE CASE 2010 TRAFFIC WITH FOLLOWING WHAT-IF FOCUS VESSELS

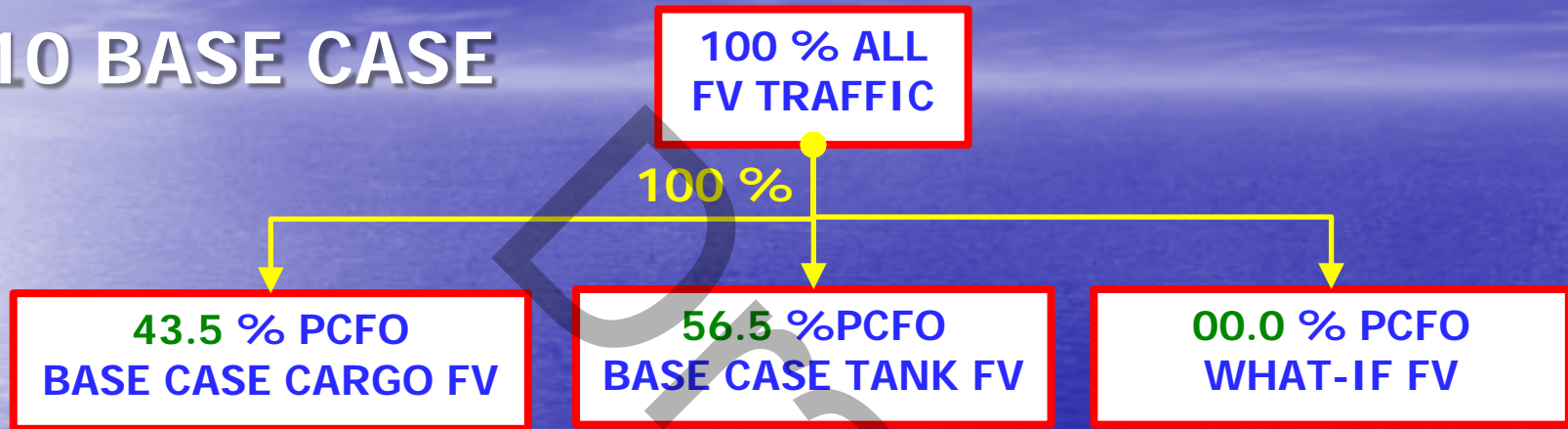
348 Delta Port Bulk Carriers + Bunkering Barges

67 Delta Port Container Ships+ Bunkering Barges

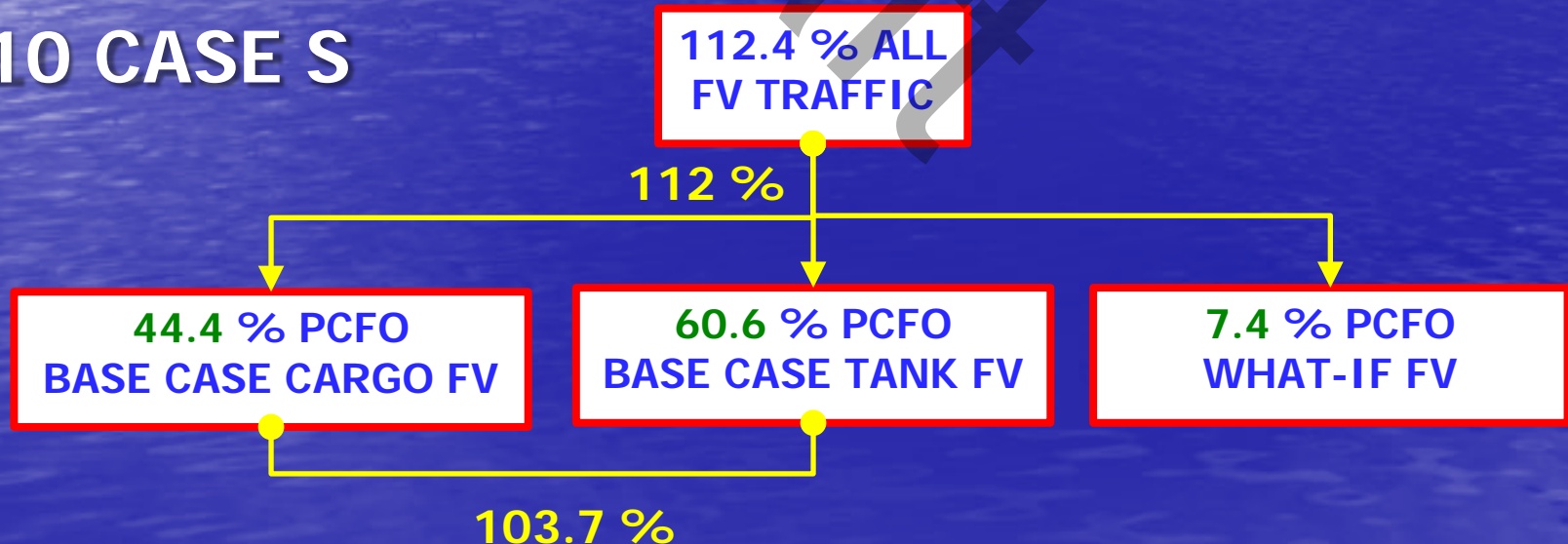
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ANNUAL COLLISION FUEL OIL LOSS

PCFO : POTENTIAL COLLISION FUEL OIL LOSS - PER YEAR

2010 BASE CASE

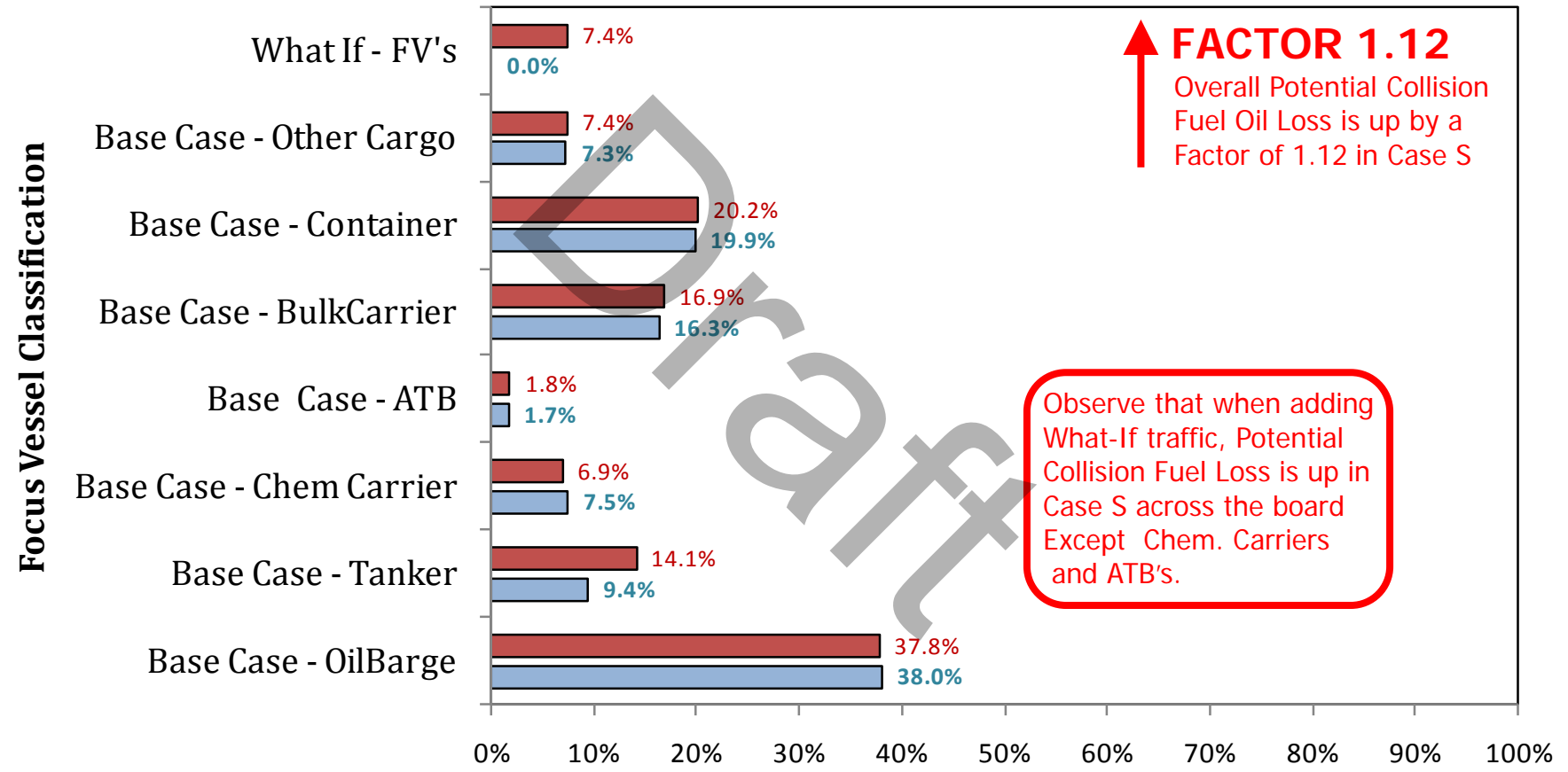


2010 CASE S



CASE S: DP 415 + BUNKERING

VTRA 2010 - COLLISION FUEL OIL LOSS



↑ FACTOR 1.12
 Overall Potential Collision Fuel Oil Loss is up by a Factor of 1.12 in Case S

Observe that when adding What-If traffic, Potential Collision Fuel Loss is up in Case S across the board Except Chem. Carriers and ATB's.

% of 2010 Potential Collision Fuel Oil Outflow (PCFO)

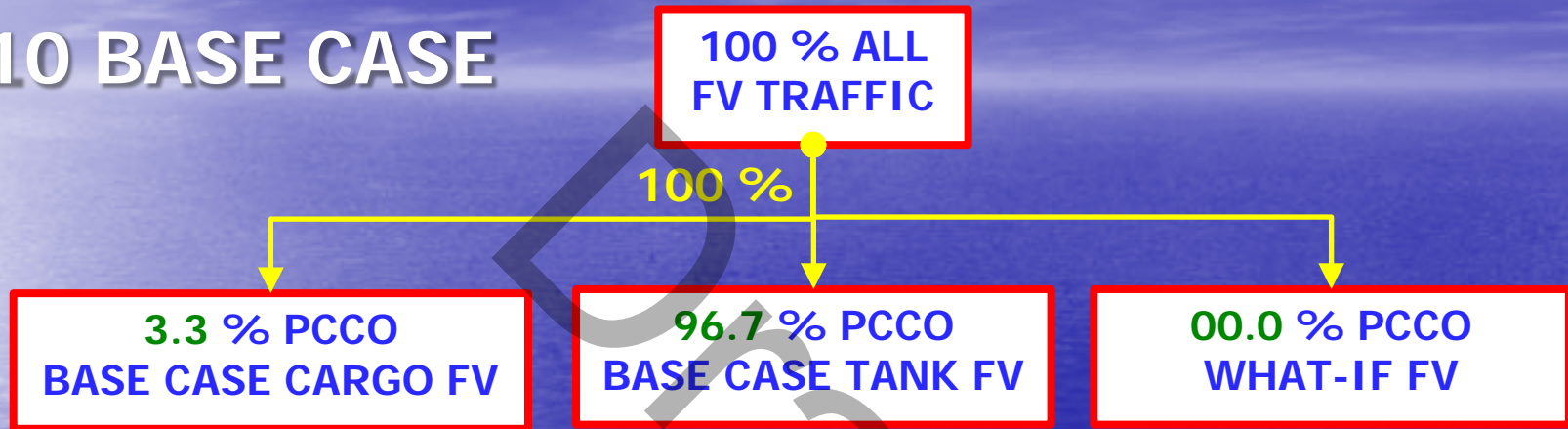
■ S: DP - 415 - 112.4% ■ P: BASE CASE 2010 - 100.0%



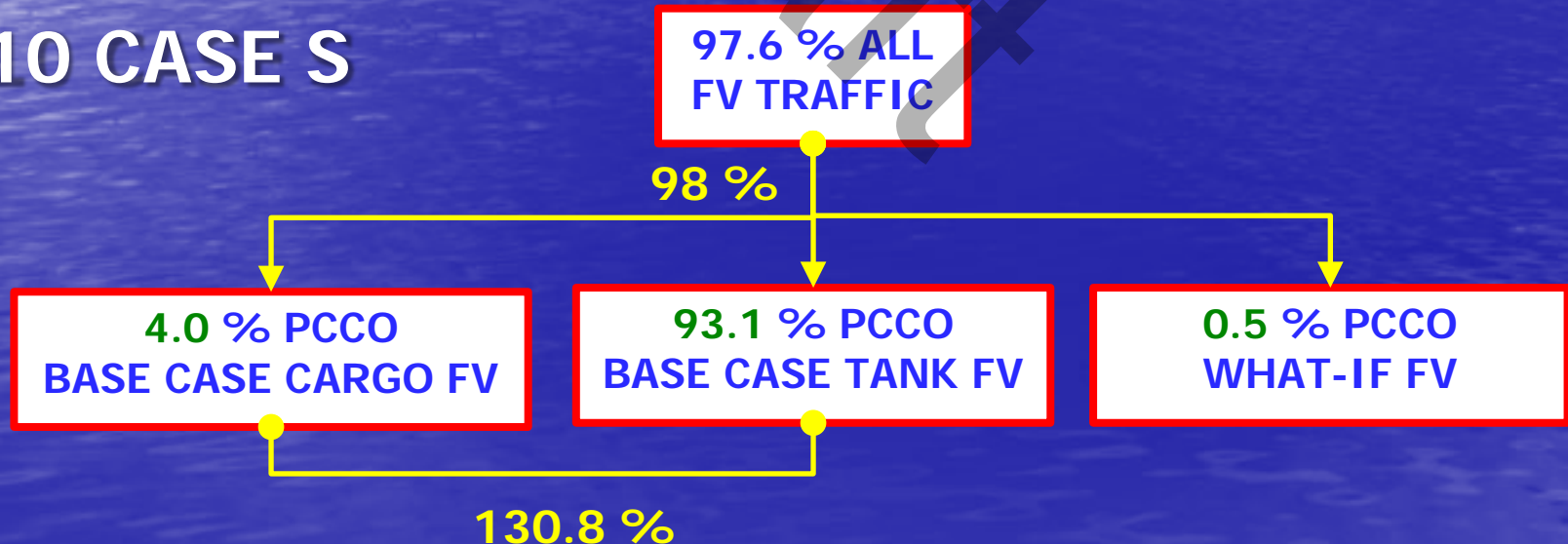
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ANNUAL COLLISION CARGO OIL LOSS

PCCO : POTENTIAL COLLISION CARGO OIL LOSS - PER YEAR

2010 BASE CASE

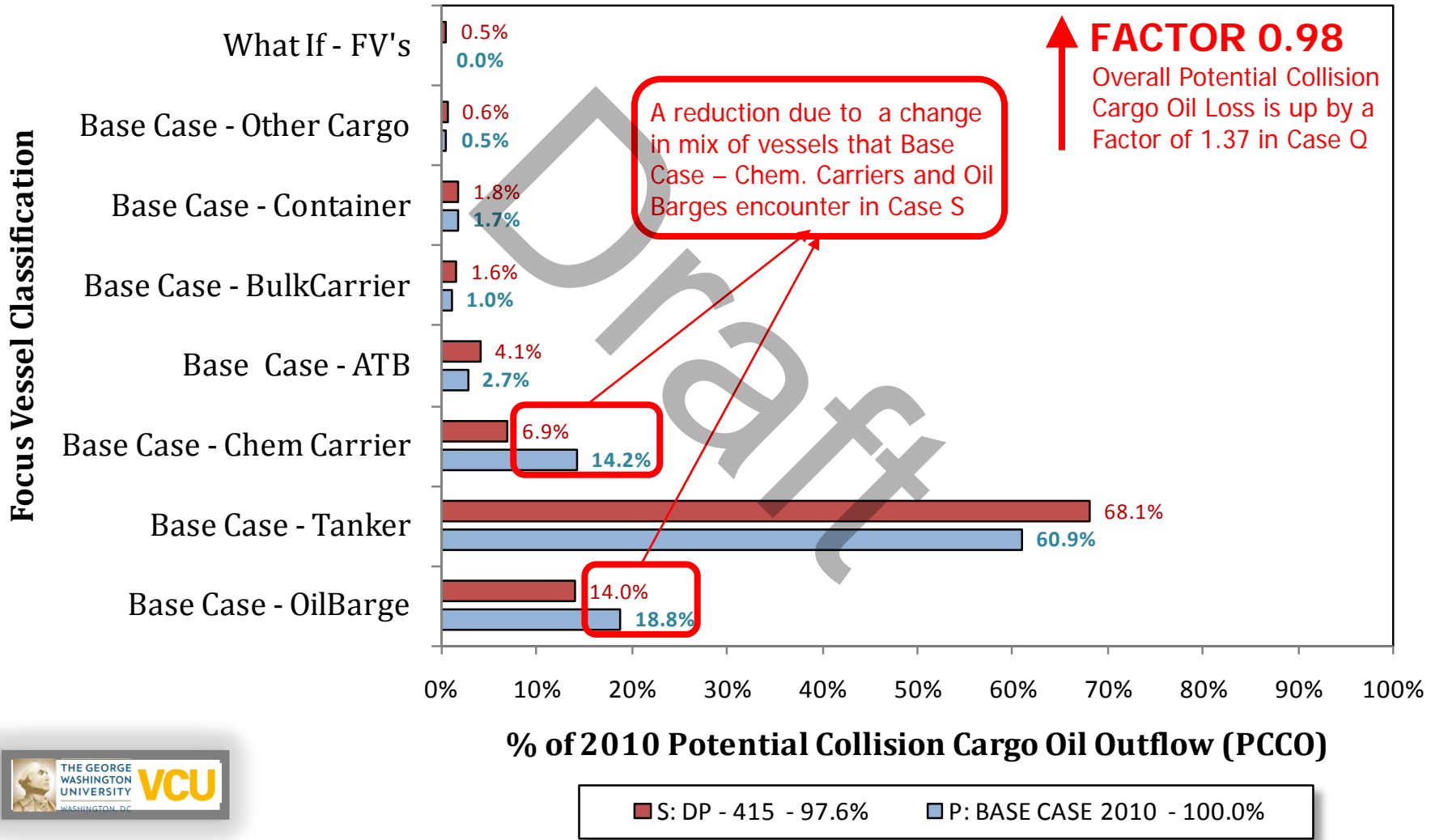


2010 CASE S



CASE S: DP 415 + BUNKERING

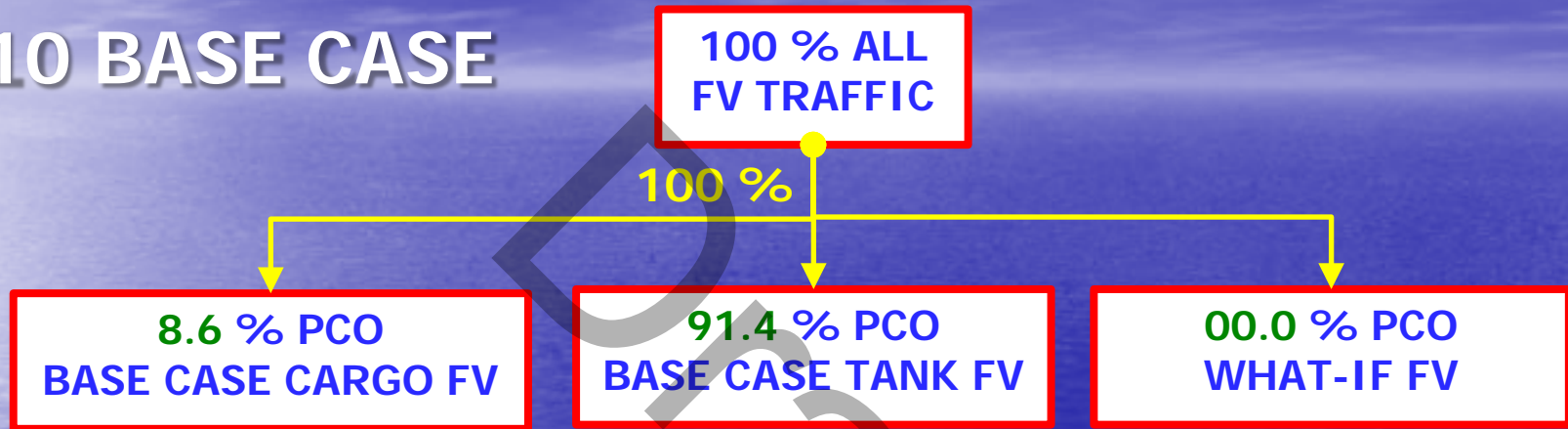
VTRA 2010 - COLLISION CARGO OIL LOSS



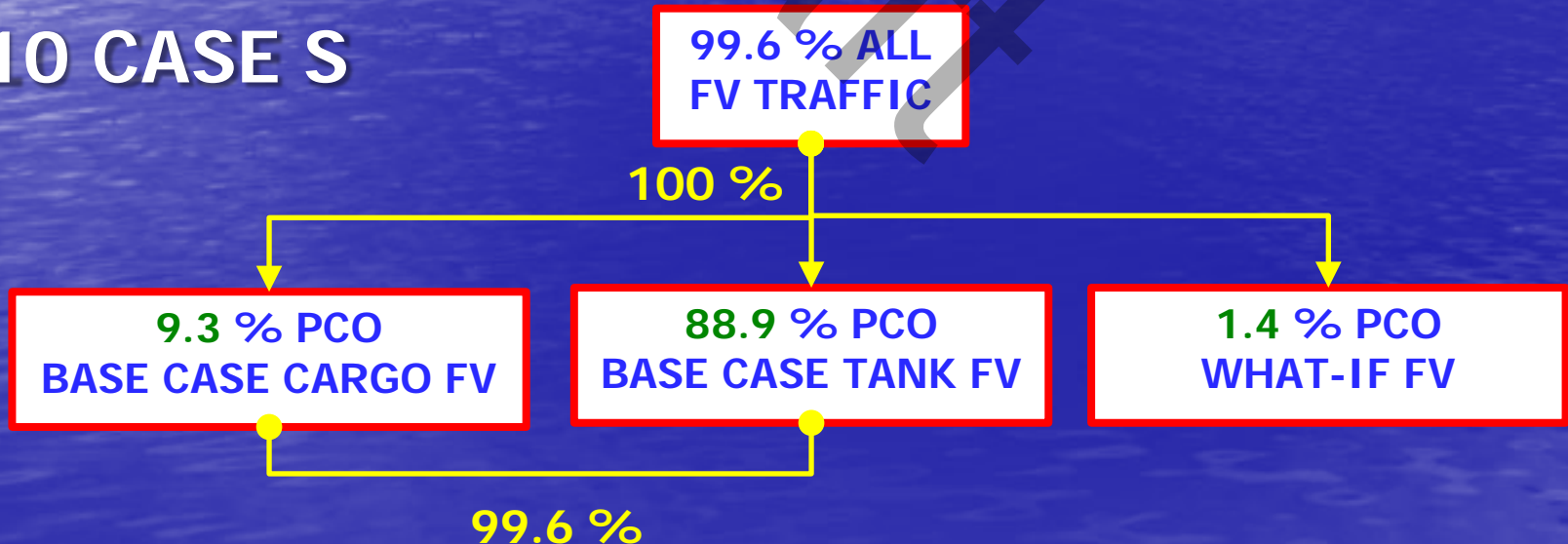
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ANNUAL COLLISION OIL (CARGO + FUEL) LOSS

PCO : POTENTIAL COLLISION OIL LOSS - PER YEAR

2010 BASE CASE

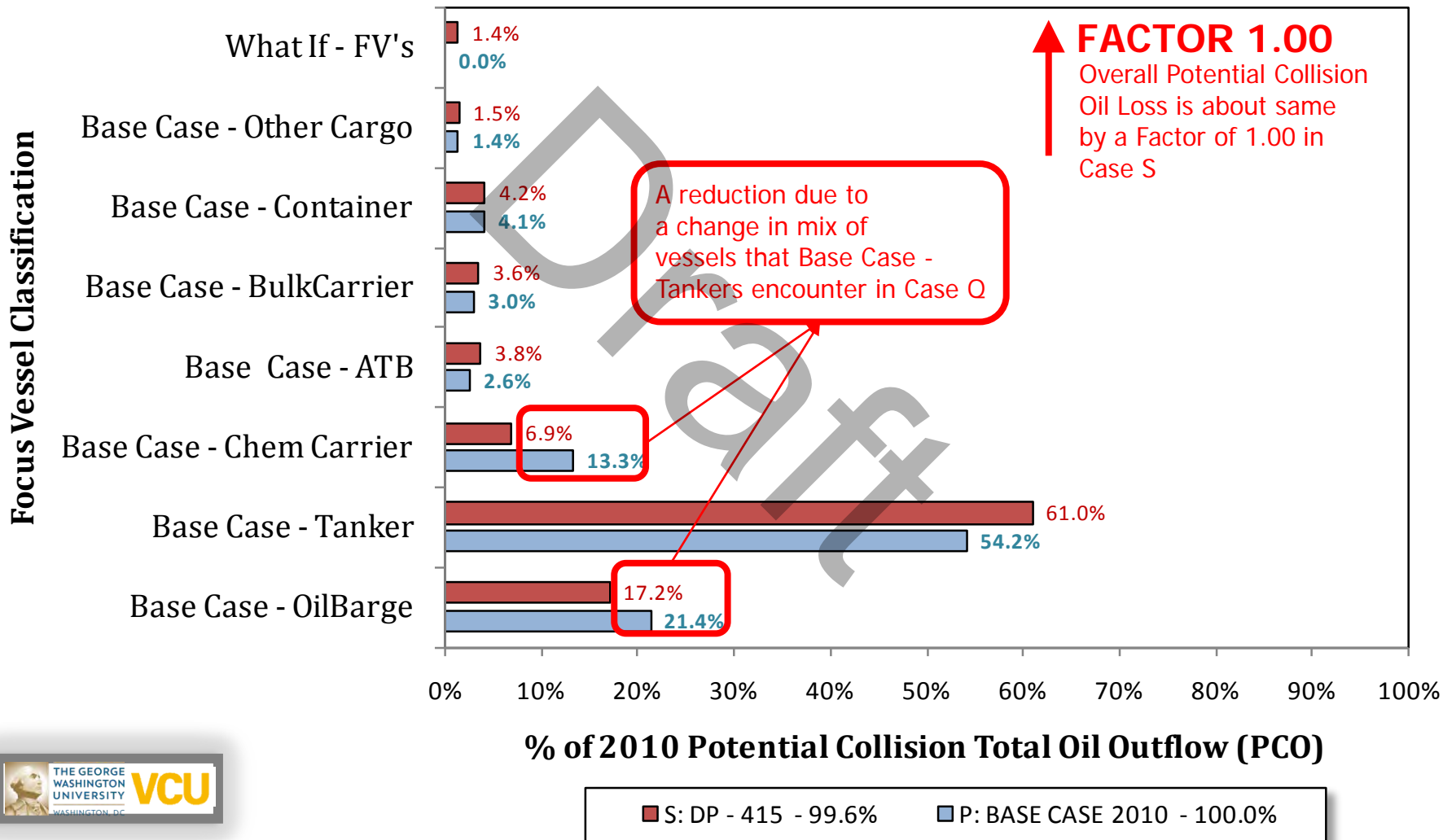


2010 CASE S



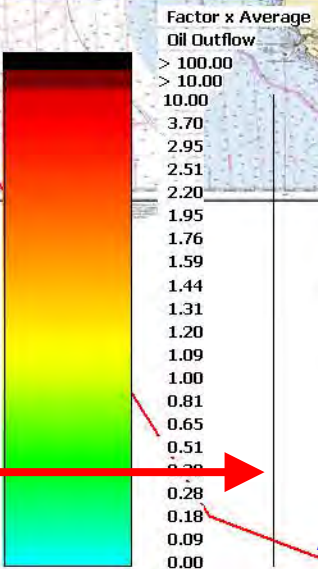
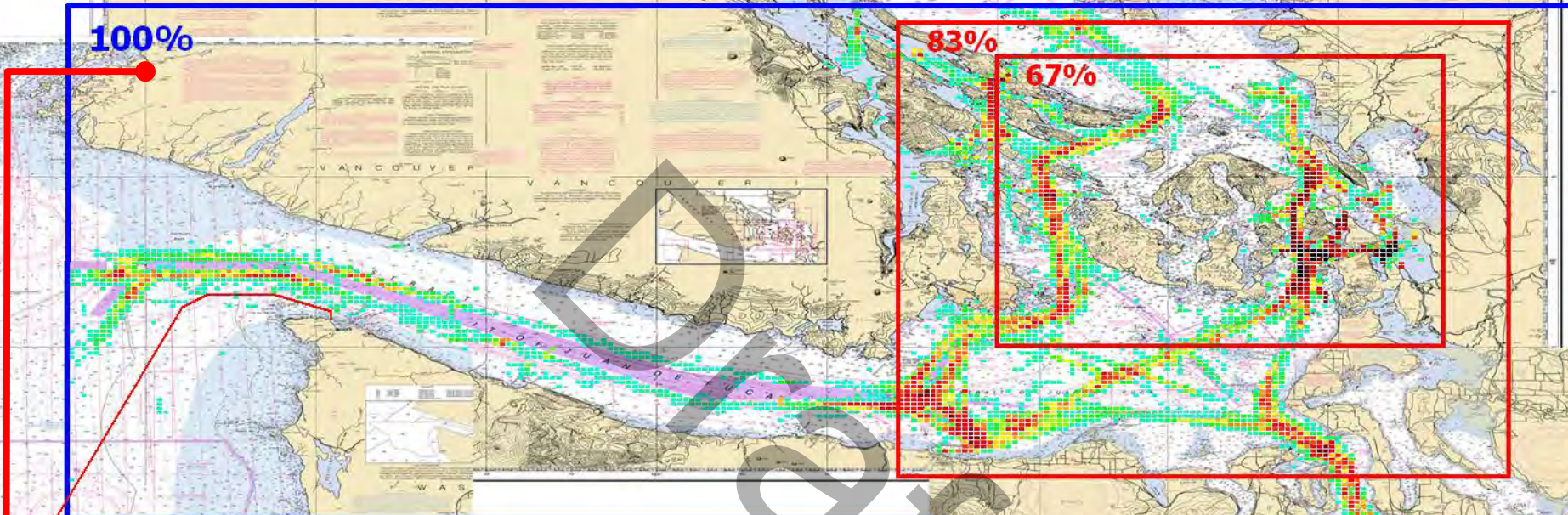
CASE S: DP 415 + BUNKERING

VTRA 2010 - COLLISION OIL LOSS (CARGO + FUEL)



P: ALL FV POTENTIAL COLLISION OIL (FUEL + CARGO) LOSS (PCO)

P: VTRA 2010 - BASE CASE - All FV

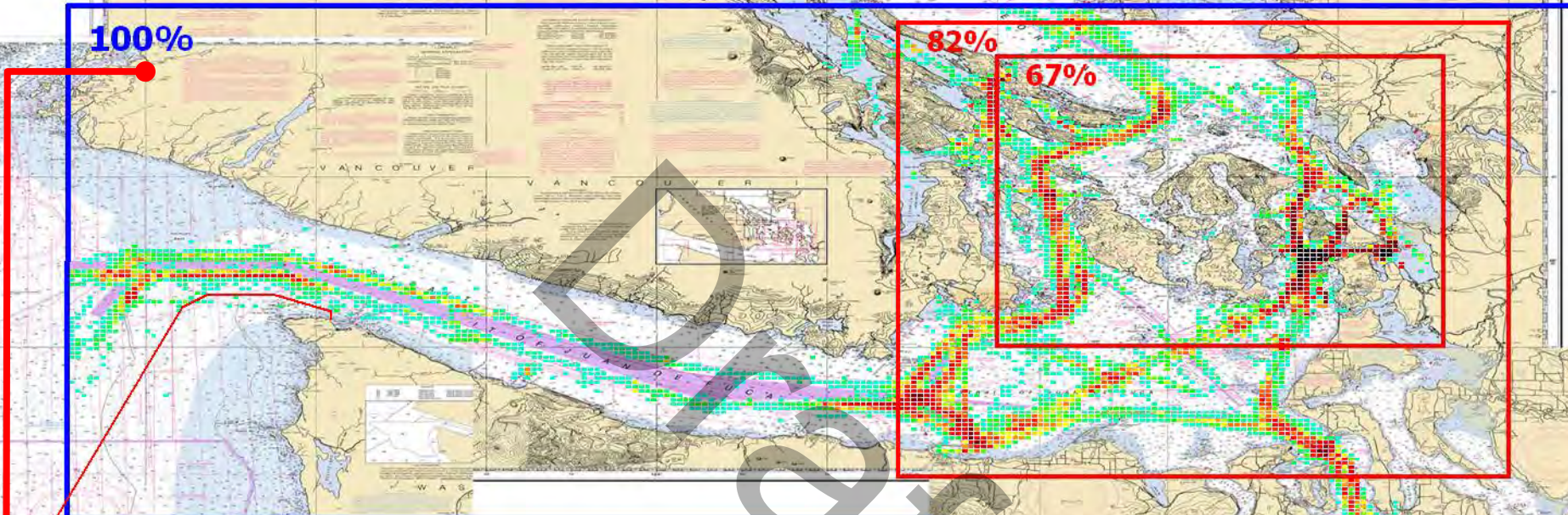


- P: POTENTIAL COLL. OIL LOSS (PCO)**
- 03.0% - BULK CARGO
 - 04.1% - CONTAINERSHIP
 - 01.4% - OTHER CARGO
 - 21.4% - OIL BARGE
 - 54.2% - TANKER
 - 13.3% - CHEMICAL CARRIER
 - 02.6% - ATB
 - 00.0% - WHAT-IF FV

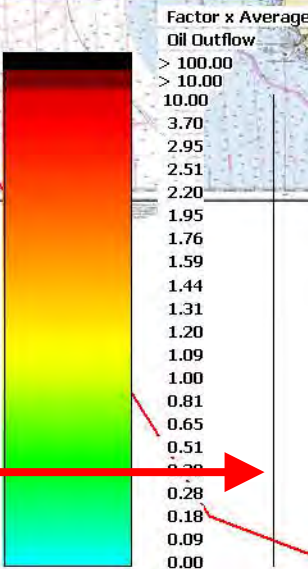
100.0% of 2010 Base Case ALL FV – PCO

S: ALL FV POTENTIAL COLLISION OIL (FUEL + CARGO) LOSS (PCO)

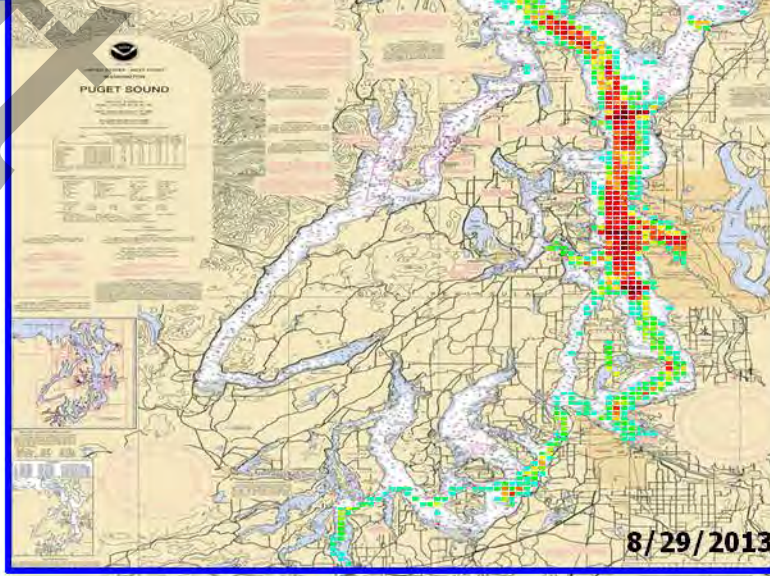
S: VTRA 2010 - Delta Port - Cont. 67 and Bulk 348 - All FV



- S: POTENTIAL COLL. OIL LOSS (PCO)**
- 03.6% - BULK CARGO
 - 04.2% - CONTAINERSHIP
 - 01.5% - OTHER CARGO
 - 17.2% - OIL BARGE
 - 61.0% - TANKER
 - 06.9% - CHEMICAL CARRIER
 - 03.8% - ATB
 - 01.4% - WHAT-IF FV

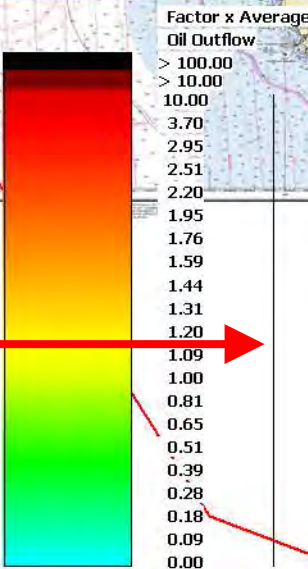
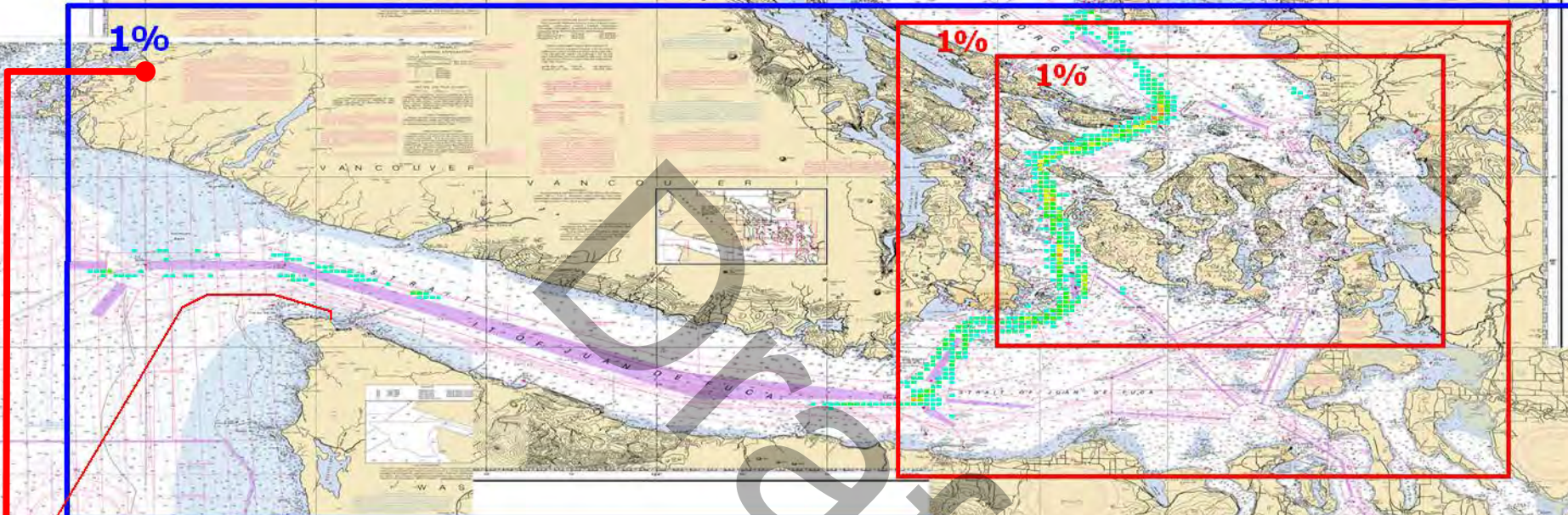


99.6% of 2010 Base Case ALL FV - PCO



S: WHAT-IF FV POTENTIAL COLLISION OIL (FUEL+CARGO) LOSS (PCO)

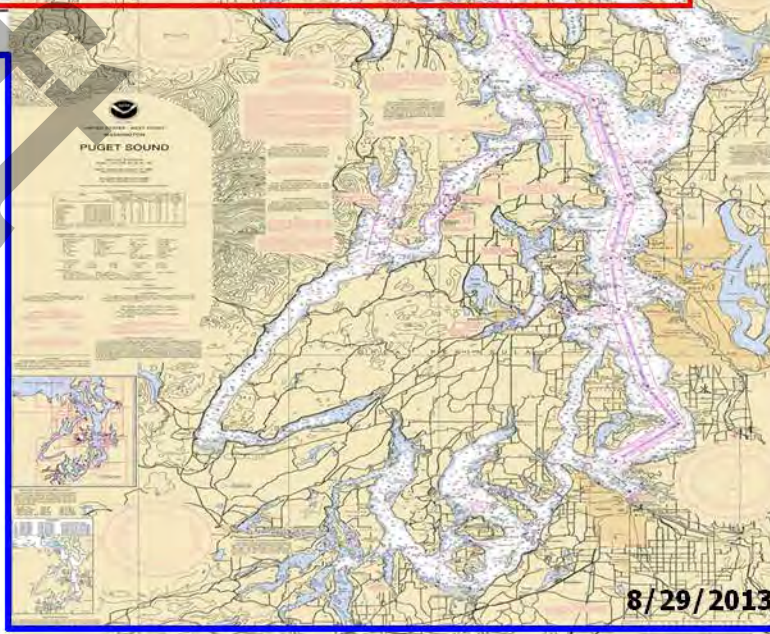
S: VTRA 2010 - Delta Port - Cont. 67 and Bulk 348



S: POTENTIAL COLL. OIL LOSS (PCO)

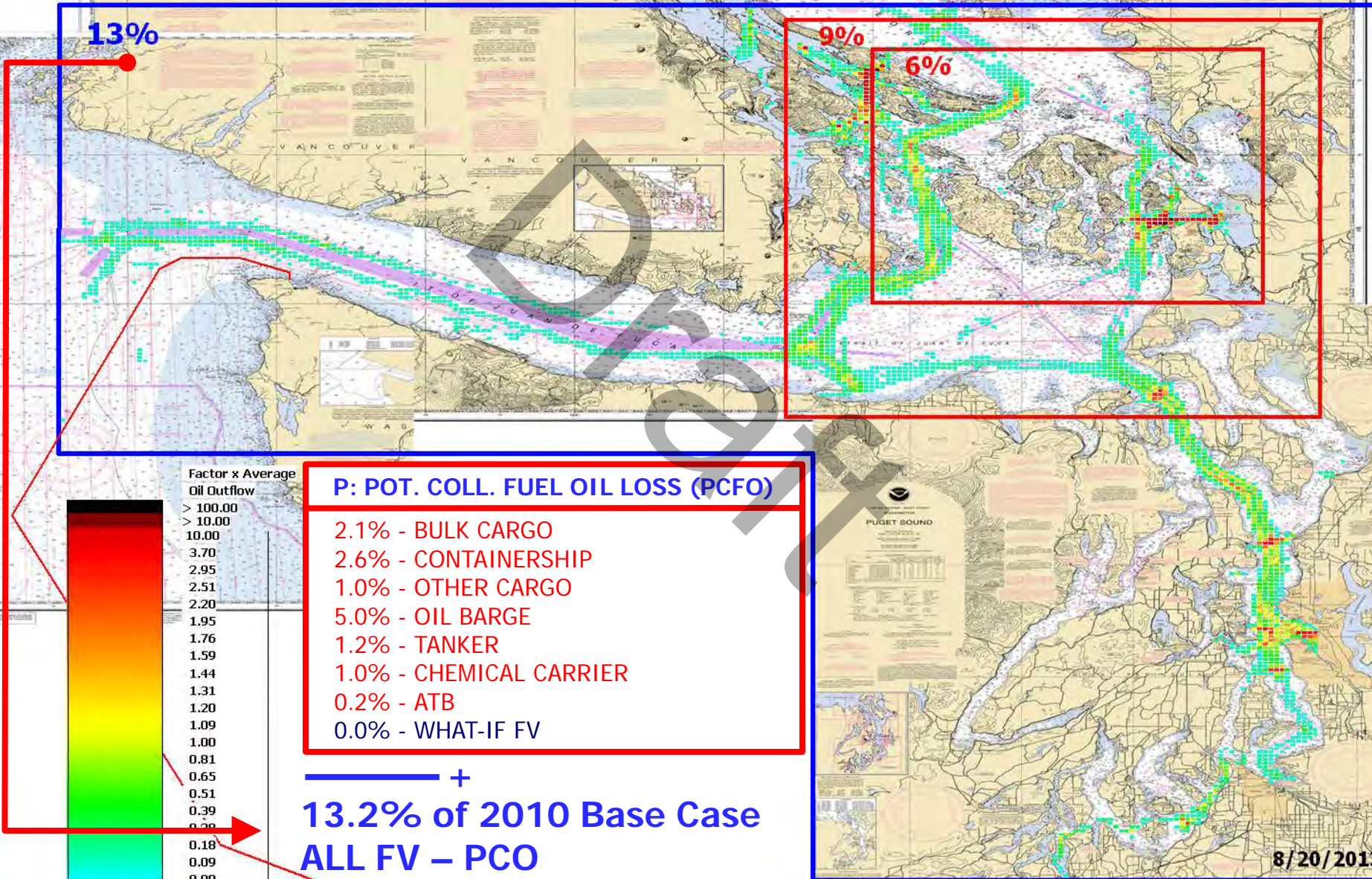
- 00.7% - BULKCARRIER
- 00.7% - CONTAINERSHIP
- 00.0% - OIL TANKER
- 00.0% - OIL BARGE

+ 1.4% of 2010 Base Case ALL FV – PCO



P: ALL FV POTENTIAL COLLISION FUEL OIL LOSS (PCFO)

P: VTRA 2010 - BASE CASE



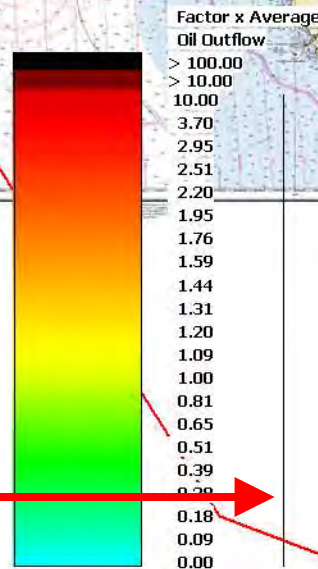
13%

9%

6%

P: POT. COLL. FUEL OIL LOSS (PCFO)

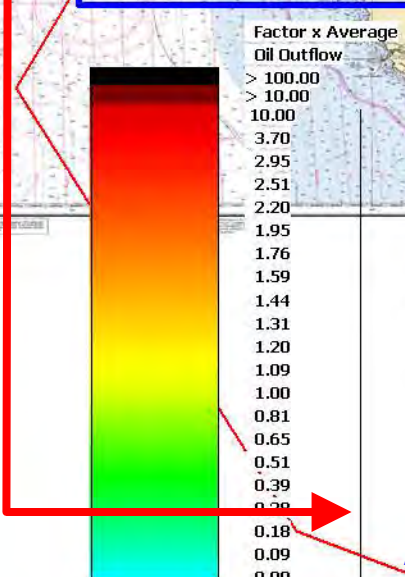
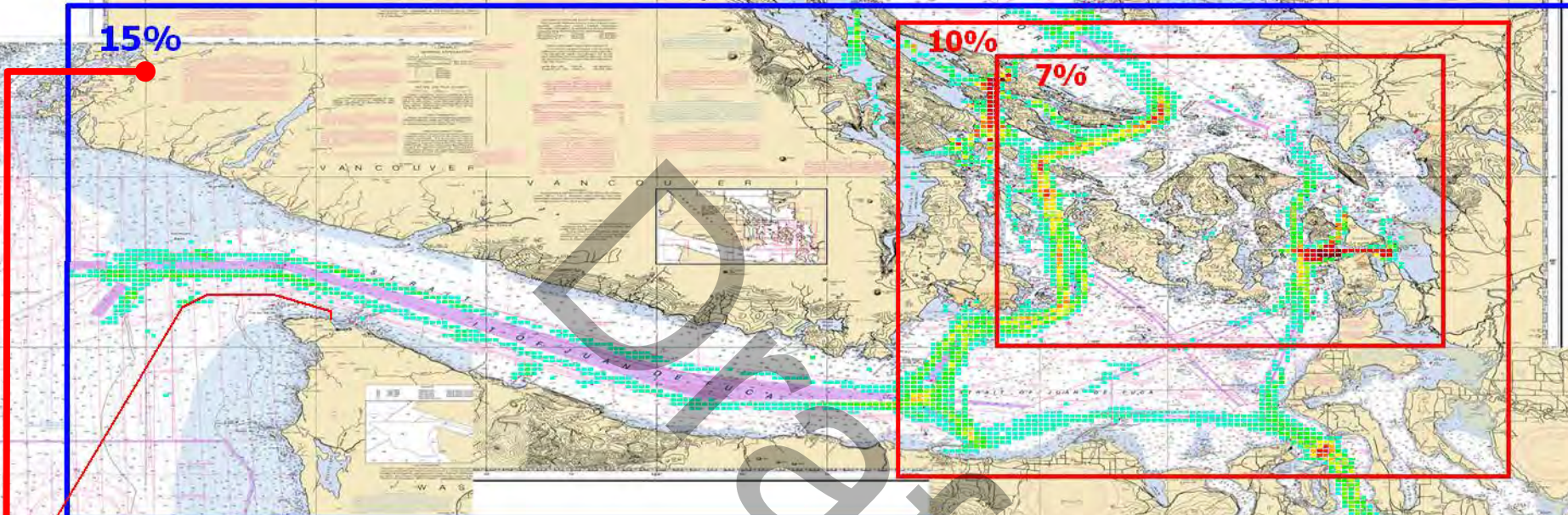
- 2.1% - BULK CARGO
- 2.6% - CONTAINERSHIP
- 1.0% - OTHER CARGO
- 5.0% - OIL BARGE
- 1.2% - TANKER
- 1.0% - CHEMICAL CARRIER
- 0.2% - ATB
- 0.0% - WHAT-IF FV



+
13.2% of 2010 Base Case
ALL FV - PCO

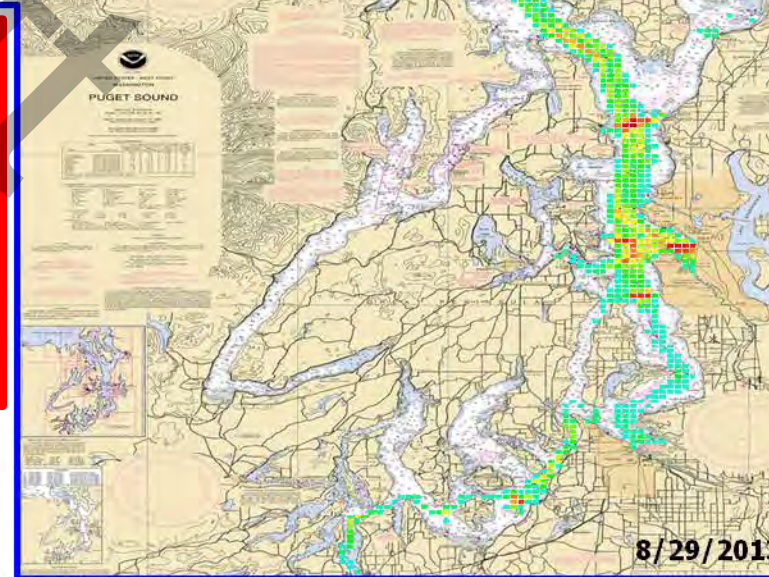
S: ALL FV POTENTIAL COLLISION FUEL OIL LOSS (PCFO)

S: VTRA 2010 - Delta Port - Cont. 67 and Bulk 348



- S: POT. COLL. FUEL OIL LOSS (PCFO)**
- 2.2% - BULK CARGO
 - 2.7% - CONTAINERSHIP
 - 1.0% - OTHER CARGO
 - 5.0% - OIL BARGE
 - 1.9% - TANKER
 - 0.9% - CHEMICAL CARRIER
 - 0.2% - ATB
 - 1.0% - WHAT-IF FV

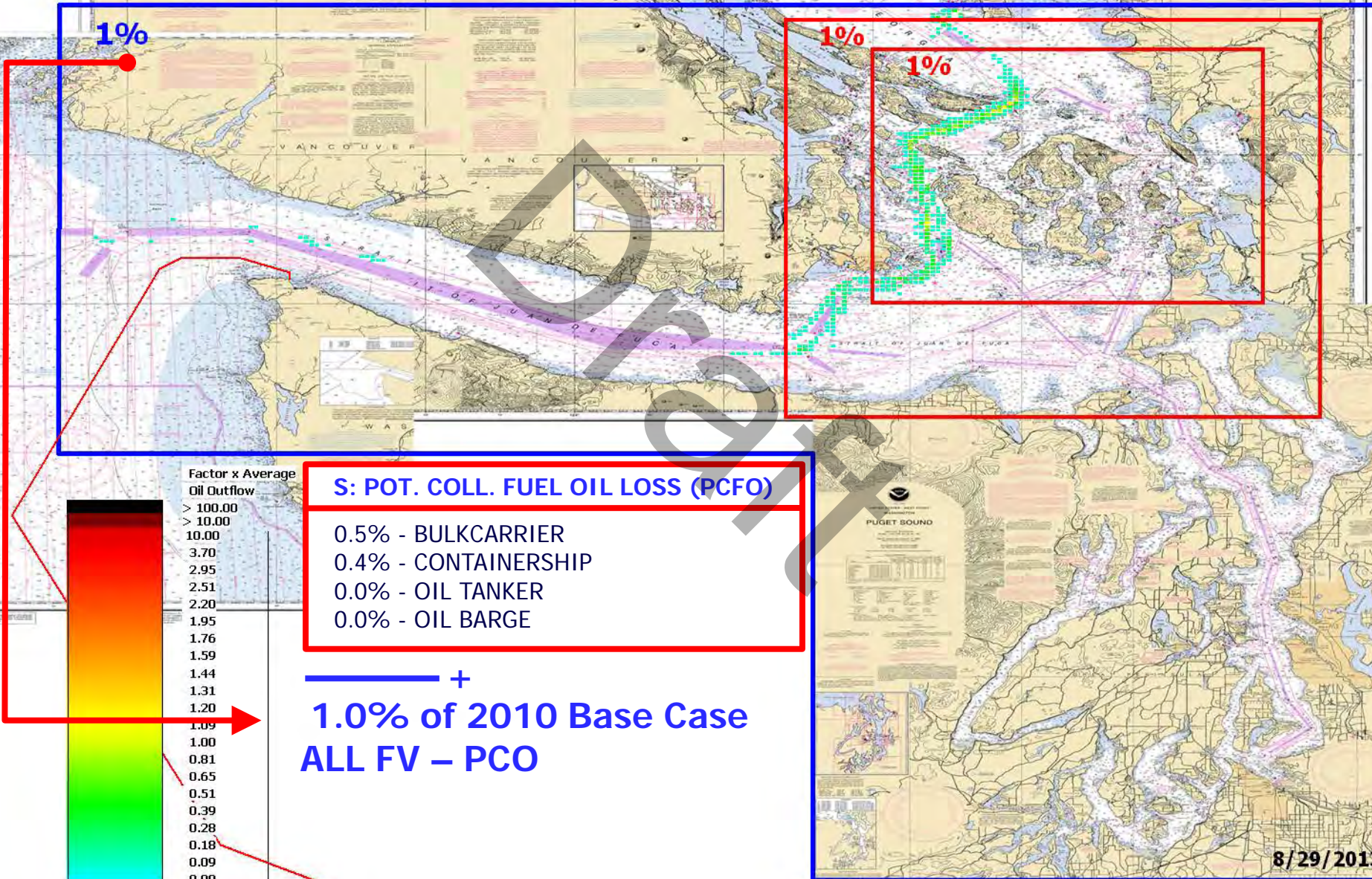
14.8% of 2010 Base Case ALL FV – PFO



S: WHAT-IF FV POTENTIAL COLLISION FUEL OIL LOSS (PCFO)

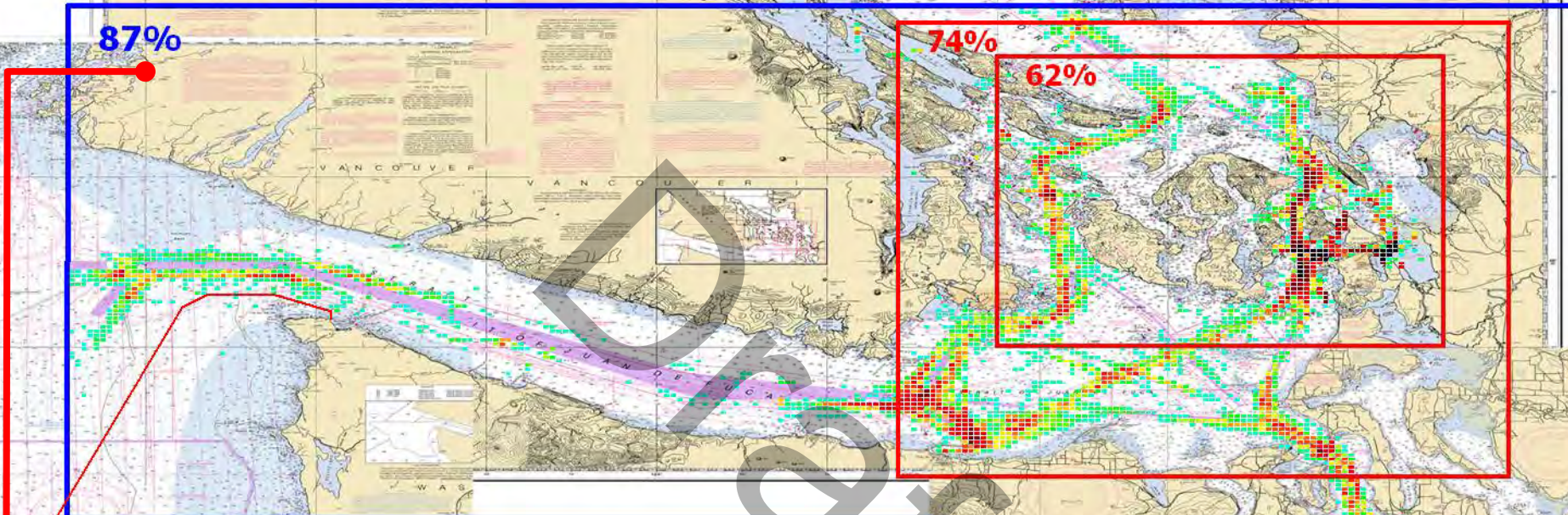


S: VTRA 2010 - Delta Port - Cont. 67 and Bulk 348



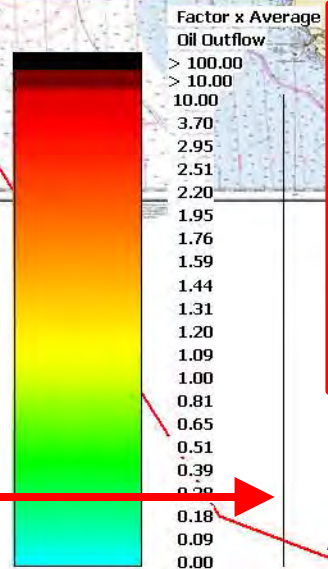
P: ALL FV POTENTIAL COLLISION CARGO OIL LOSS (PCCO)

P: VTRA 2010 - BASE CASE



P: POT. COLL. CARGO OIL LOSS (PCCO)

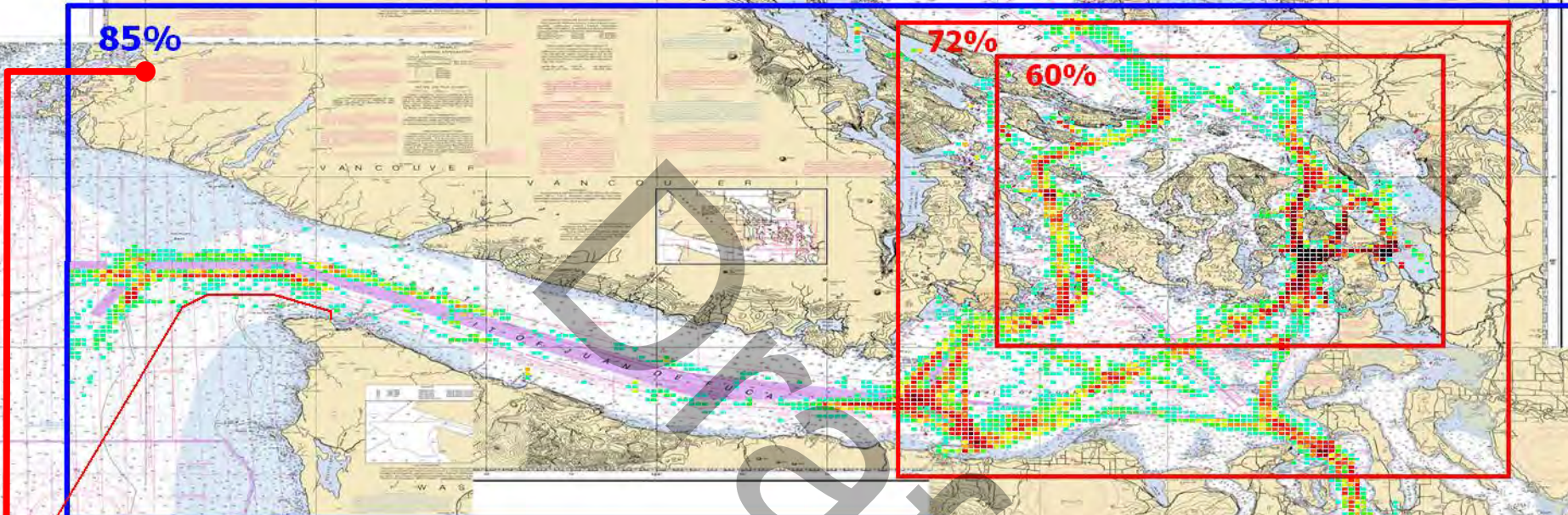
- 00.9% - BULK CARGO
- 01.5% - CONTAINERSHIP
- 00.5% - OTHER CARGO
- 16.3% - OIL BARGE
- 52.9% - TANKER
- 12.4% - CHEMICAL CARRIER
- 02.3% - ATB
- 00.0% - WHAT-IF FV



86.8% of 2010 Base Case ALL FV – PCO

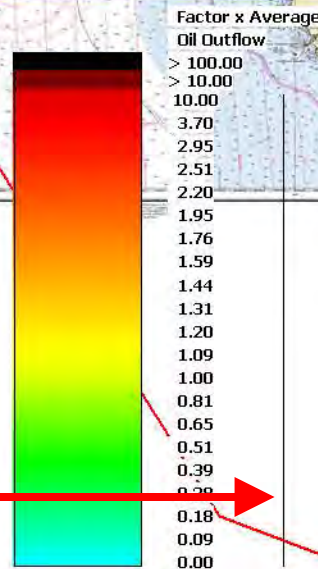
S: ALL FV POTENTIAL COLLISION CARGO OIL LOSS (PCCO)

S: VTRA 2010 - Delta Port - Cont. 67 and Bulk 348



S: POT. COLL. CARGO OIL LOSS (PCCO)

- 01.4% - BULK CARGO
- 01.6% - CONTAINERSHIP
- 00.5% - OTHER CARGO
- 12.2% - OIL BARGE
- 59.1% - TANKER
- 06.0% - CHEMICAL CARRIER
- 03.5% - ATB
- 00.4% - WHAT-IF FV

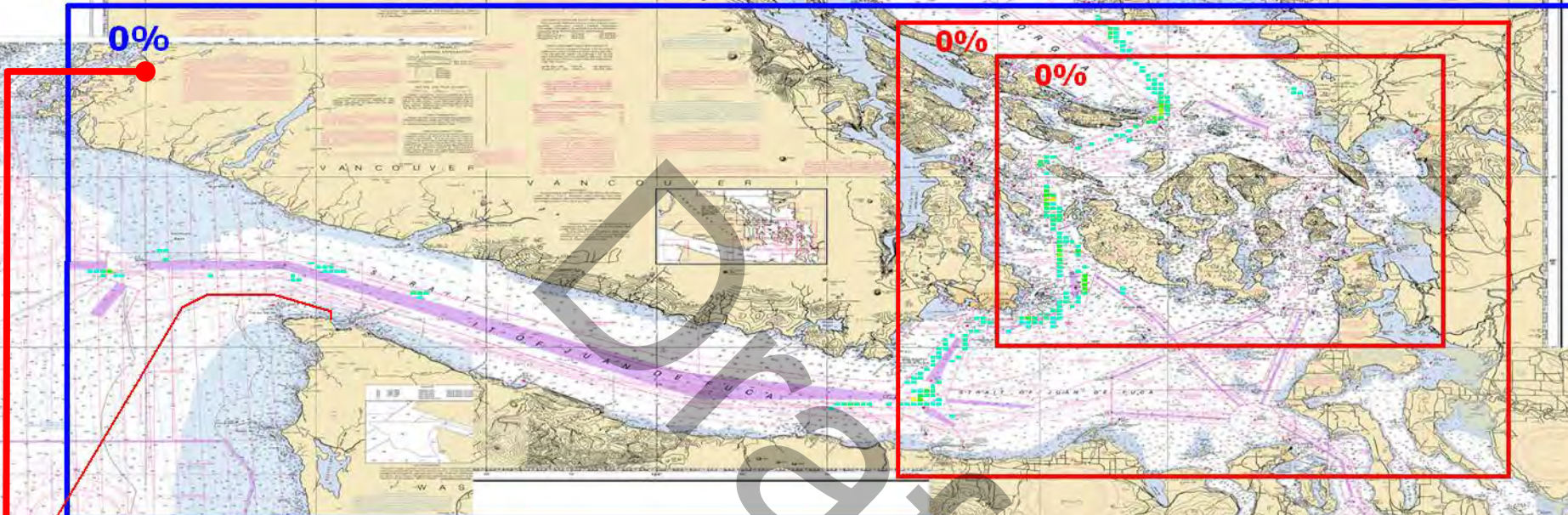


84.8% of 2010 Base Case ALL FV – PCO

S: WHAT-IF FV POTENTIAL COLLISION CARGO OIL LOSS (PCCO)



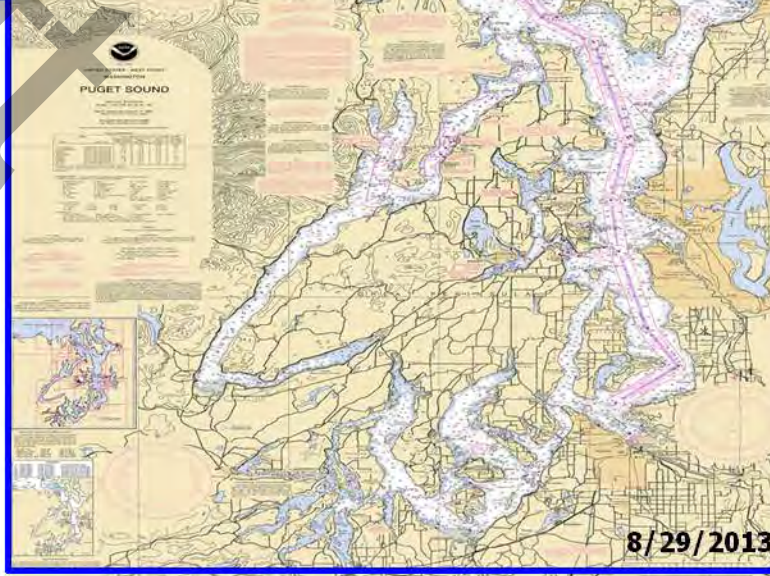
S: VTRA 2010 - Delta Port - Cont. 67 and Bulk 348



S: POT. COLL. CARGO OIL LOSS (PCCO)

- 00.0% - BULKCARRIER
- 00.0% - CONTAINERSHIP
- 00.0% - OIL TANKER
- 00.0% - OIL BARGE

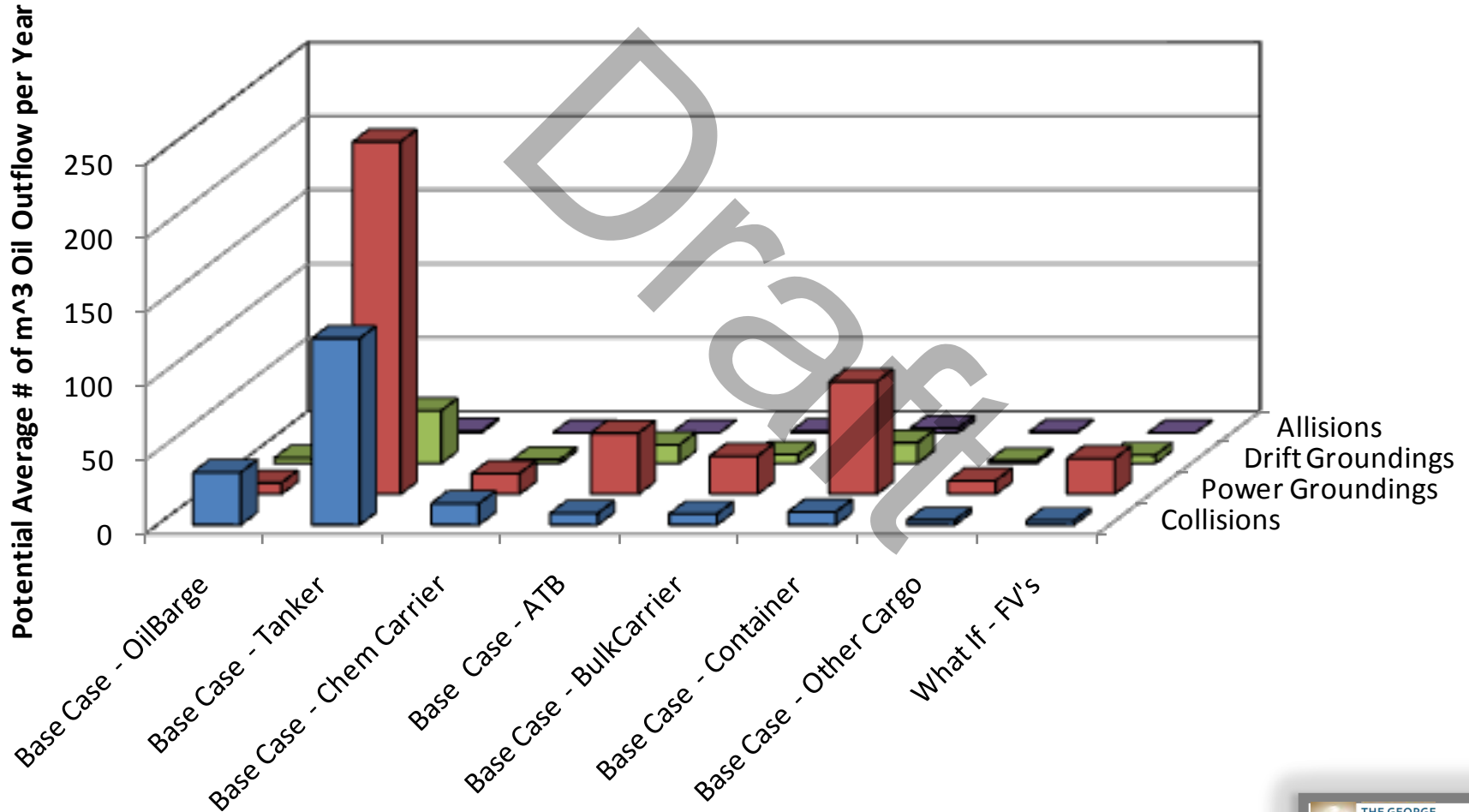
+
**0.0% of 2010 Base Case
ALL FV - PCO**



A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ACCIDENT FREQUENCY AND ACCIDENT TYPE

CASE S: DP 415 + BUNKERING

S - VTRA 2010 : Potential Average # of m³ Oil Outflow per Year



CASE S: DP 415 + Bunkering

S - VTRA 2010 : Potential Average # of m³ Oil Outflow per Year

Focus Vessel	Collisions	Power Groundings	Drift Groundings	Allisions	Total
Base Case - OilBarge	17.2%	1.8%	4.9%	0.0%	6.7%
Base Case - Tanker	61.0%	57.5%	46.7%	21.6%	57.0%
Base Case - Chem Carrier	6.9%	3.4%	3.4%	0.0%	4.4%
Base Case - ATB	3.8%	10.0%	16.4%	0.0%	8.8%
Base Case - All Tank FV's	88.9%	72.6%	71.5%	21.6%	76.9%
Base Case - BulkCarrier	3.6%	6.2%	7.9%	16.7%	5.7%
Base Case - Container	4.2%	18.3%	18.3%	52.2%	14.5%
Base Case - Other Cargo	1.5%	2.2%	2.4%	8.6%	2.1%
Base Case - All Cargo FV's	9.3%	26.7%	28.6%	77.6%	22.2%
Base Case - All FV's	98.2%	99.4%	100.1%	99.2%	99.1%
What If - FV's	1.4%	5.8%	7.3%	0.0%	4.6%
Total - Base Case + What- IF	99.6%	105.1%	107.4%	99.2%	103.7%

S - VTRA 2010 : Potential Average # of m³ Oil Outflow per Year

Focus Vessel	Collisions	Power Groundings	Drift Groundings	Allisions	Total
Base Case - OilBarge	35.5	7.6	3.8	0.0	46.9
Base Case - Tanker	126.3	238.6	35.7	1.2	401.9
Base Case - Chem Carrier	14.3	14.0	2.6	0.0	30.9
Base Case - ATB	7.8	41.3	12.6	0.0	61.7
Base Case - All Tank FV's	184.0	301.6	54.6	1.2	541.4
Base Case - BulkCarrier	7.4	25.8	6.0	1.0	40.2
Base Case - Container	8.7	76.2	14.0	3.0	101.9
Base Case - Other Cargo	3.1	9.1	1.8	0.5	14.6
Base Case - All Cargo FV's	19.3	111.0	21.9	4.4	156.6
Base Case - All FV's	203.3	412.6	76.5	5.7	698.0
What If - FV's	2.9	24.0	5.6	0.0	32.5
Total - Base Case + What- IF	206.2	436.6	82.0	5.7	730.5