PROCEDURES MANUAL
FOR
DESIGN AND REVIEW
OF
MARINE SHORT-RANGE
AIDS TO NAVIGATION SYSTEMS
(TP9677)

SUPPLEMENT

DECEMBER 1993

TABLE OF CONTENTS

PROCEDURES MANUAL FOR DESIGN AND REVIEW OF MARINE SHORT-RANGE AIDS TO NAVIGATION SYSTEMS (TP9677)

REVISION N° 01

Date: January 14, 1992

List of Corrections.

Page 2-4
Paragraph 2.3

Add: Telephone number (416)739-4335
Fax (416)739-4446, attention Mike Webb.

Page 2-5
Last Paragraph

After: from the precise area alone.
Add: The accepted rule of thumb is that at least 200 observations are required per month to adequately describe the monthly climate.

Page 2-7, 2-10, 3-10
Section 1-4, (Site Data Sheet)

Delete: Long-Range Commercial and Local Commercial.
Substitute: Certified Commercial and Uncertified Commercial.

navie de commerce agréé (non agréé)

Page 3-5
Paragraph 3.4.5

Delete: When the wind is from a direction.
Add: When the wind is from any direction.

Page 3-7
Paragraph 3.4.8, line 7

Delete: approaching.

Page 3-8
Top right hand corner of chart.

Add: See enlarged chart page 4-17 for detail.

Page 3-9
Bottom of page

Add: Note: minimum depth allowance column should be divided into open and confined waters.

Page 4-6
Top of page

Delete: Long-Range Commercial and Local Commercial
Substitute: Certified Commercial and Uncertified Commercial.

Page 4-7
First Paragraph, Last Sentence

After: describable
Add: visual aspects. The determination of whether a shoreline is distinctive enough for a positive identification is a local decision based on user consultation and C.G. professional judgement.

Page 5-3
Third Paragraph

Delete: Long-Range Commercial and Local Commercial
Substitute: Certified Commercial and Uncertified Commercial.

Page 5-6
First Paragraph, second, third and fifth sentence

Delete: Long-Range Commercial and Local Commercial
Substitute: Certified Commercial and Uncertified Commercial.

Page 5-7
Paragraph 5.4.5

Delete: Long-Range Commercial and Local Commercial
Substitute: Certified Commercial and Uncertified Commercial.

Page 5-9
Paragraph 5.4.9.

Delete: Long-Range Commercial
Substitute: Certified Commercial

Page 6-3
Third Paragraph

Delete: Long-Range Commercial
Substitute: Certified Commercial

Page 6-4
Paragraph 6.4.1

Delete: (cf. p.2-10)
Substitute: (ex. page 3-8 and 4-17)

Page 6-7
First Paragraph

Delete: last sentence

Page 6-8
Paragraph 6.4.5 (a)

Delete: are the most precise and complete mode of marking channels. They

Page (after Appendices marker tab)
Supplementary References.

Add: 17. A Study of the Radar Range of Navigation Buoys: Technical Report, Fleet Technology Limited, Kanata, March 1988, Submitted to Floating Aids to Navigation Division CCG, Ottawa.

Page A-1
Table A-1

Amend:
(1) 4'6", radar range 4 to 5.
(2) 6'0", radar range 5 to 7, visual range 3.
(3) 9'6" bell, radar range 6 to 8, visual range 4 to 5.5.
(4) 9'6" whistle, radar range 6 to 8, visual range 4 to 5.5.
(6) 1.5m Discus, radar range 4 to 5.
(17) Small foam buoys, visual range 0.25.
(20) long spar, radar range 2 to 2.5.
(21) short spar, radar range 1 to 2.5.
(22) short spar O.R.T. radar range 1 to 2.5, visual range 0.5.

Page A-1
Note 1.

After: calm weather.
Add: Radar ranges are also based in part on a study conducted for CCG. See Supplementary References item 17.

Page A-1
Bottom of page

Add: 3. Under some circumstances, the radar reflective range of some standard buoys may be substantially increased by the addition of tetrahedron or octahedron radar reflectors. The standard sizes are:

1) 8" tetrahedron
2) 9" octahedron
3) 12"
4) 18"
5) 24"
6) 31"

Page A-1

Add: 4. Radar range for any aid to navigation is reduced by sea condition.

Example: 9'6" buoy, calm seas, radar range 6-8
9'6" buoy, building seas, radar range 4-5
9'6" buoy, severe seas, radar range 3-4

Page A-4

Add attached sheet Page A-4(i)

Page A-5

Add attached sheet Page A-5(i)

Page A-7

Add attached sheet Page A-7(i)

Page A-8

Substitute attached sheet A-8

Page A-10

Add attached sheet Page A-10(i) on DCB-10 with modified lamp sizes.

Page A-11

Add attached sheet A-11(i)

Page A-12
First column.

Delete: 36
Substitute: 360

Page A-19, A-20
Bottom of page

Add: Estimate design distance for non-standard sizes by using surface area of the aid.

Page B-5

Delete: Long-Range Commercial Vessels (Category I)
Substitute: Certified Commercial Vessels (Category I)

Page B-7
Under Racon

Last line, after: and obtain
Add: a range and a bearing.

Page C-2

Delete: Second paragraph
Substitute: The perception requirement (P) calculation is normally required for Category II and III users only, since Category I vessels will make landfall using on-board navigational aids. Instrument approach (radar) radial error may require calculation when landfall visual confirmation is required (see page C-8).

Page C-7
Paragraph A and C

Delete: Long-Range Commercial
Substitute: Certified Commercial

Page C-7
Paragraph B

Delete: Local Commercial
Substitute: Uncertified Commercial

Page C-8
Last Paragraph

Delete: Distance between the vessel and the target/mark
Substitute: Radar range scale in use. (Typical range scales are 1/4, 1/2, 3/4, 1.5, 3, 6, 12, 24 and 48.)

Page C-9
First line

After: The maximum allowed inaccuracy of a
Add: single

Page C-10

Delete: Sine (wherever shown)
Substitute: Tan

Tideland Signal

ML-300 (300 mm acrylic lens)

Effective Intensity

Flash Duration (sec)		0.3	0.5	1.0	2.0	Fixed
Lens Colour	Lamp					
Clear	0.55 A	130	172	211	234	260
	0.77 A	200	264	324	360	400
	1.15 A	247	346	440	495	550
	2.03 A	409	630	819	934	1050
	3.05 A	N/A	810	1155	1335	1500
	250 W	2527	3888	5054	5767	6480
Red or Green	0.55 A	37	48	59	66	73
	0.77 A	56	74	91	101	112
	1.15 A	69	97	123	139	154
	2.03 A	115	176	229	262	294
	3.05 A	N/A	227	323	374	420
	250 W	707	1088	1415	1614	1814
Yellow	0.55 A	85	112	137	152	169
	0.77 A	130	172	211	234	260
	1.15 A	161	226	286	322	358
	2.03 A	266	410	533	608	683
	3.05 A	N/A	526	751	868	975
	250 W	1643	2527	3285	3749	4212

Automatic Power (250mm acrylic lens)

Effective Intensity

Flash Duration (sec)		0.3	0.5	1.0	2.0	Fixed
Lens Colour	Lamp					
Clear	0.55 A	90	119	146	162	180
	0.77 A	135	178	219	243	270
	1.15 A	180	252	320	360	400
	2.03 A	300	462	601	685	770
	3.05 A	N/A	567	808	934	1050
	250 W	1732	2664	3463	3952	4440
Red or Green	0.55 A	28	37	45	50	56
	0.77 A	42	55	68	76	84
	1.15 A	56	78	99	112	124
	2.03 A	93	143	186	213	239
	3.05 A	N/A	175	250	289	325
	250 W	537	826	1073	1225	1376
Yellow	0.55 A	64	84	104	115	128
	0.77 A	96	127	156	173	192
	1.15 A	128	179	227	256	284
	2.03 A	213	328	427	487	547
	3.05 A	N/A	403	574	664	746
	250 W	1229	1891	2459	2805	3152

DLD-300 Pressed Glass Lens

Effective Intensity

Clear Lens	0.5 sec.	1 sec.	2 sec.	3 sec.	Fixed
*100w Traffic Lamp	640	780	870	900	970
250w Quartzline Lamp	1790	2300	2600	2700	2920
500w Quartzline Lamp	2670	3750	4300	4490	4860
Red Lens					
*100w Traffic Lamp	170	210	230	240	260
250w Quartzline Lamp	470	610	690	720	770
500w Quartzline Lamp	710	990	1140	1190	1290
Green Lens					
*100w Traffic Lamp	110	140	150	160	170
250w Quartzline Lamp	310	400	450	470	510
500w Quartzline Lamp	470	660	750	790	850

Fixed Light	Clear Lens	Red Lens	Green Lens
*100w Mercury Lamp	1500	N/A	N/A
*175w Mercury Vapour Lamp	2400	N/A	N/A
*250w High Pressure Sodium Lamp	7800	N/A	N/A
175w Metalarc Lamp	7600	2000	1300

NOTE

THE ABOVE LAMPS MARKED * ARE NOT STANDARD ITEMS AND SHOULD BE REPLACED WITH STANDARD ONES WHEN THE STOCKS ARE CONSUMED.

AUTOMATIC POWER FA-240

RANGE LIGHT

EFFECTIVE INTENSITY

		LENS			
Lens Colour	Lamp (12v)	Flat-lite	3.5° x 2.0°	8°	30°
Clear	0.55 A	20,000	5,760	3,300	800
	0.77 A	30,000	10,300	6,250	1,500
	1.15 A	57,000	14,300	8,700	2,150
	2.03 A	80,000	30,700	18,700	4,480
	3.05 A	115,000	42,100	24,400	6,140
	*1.35 A	62,000	18,000	10,800	2,700
Red or Green	0.55 A	5,000	1,610	920	220
	0.77 A	8,400	2,880	1,750	420
	1.15 A	16,000	4,000	2,440	600
	2.03 A	22,400	8,600	4,980	1,250
	3.05 A	32,200	11,800	6,830	1,720
	*1.35 A	17,400	5,040	3,020	760
Yellow	0.55 A	16,000	4,600	2,640	640
	0.77 A	24,000	8,240	5,000	1,200
	1.15 A	45,600	11,440	6,960	1,720
	2.03 A	64,000	24,560	14,240	3,580
	3.05 A	92,000	33,680	19,520	4,880
	*1.35 A	49,000	14,400	8,640	2,160

NOTE:

The above 1.35 A lamps marked * are not standard items.

EFFECTIVE INTENSITY OF ROTATING BEACON

DCB -10 WITH 120 VOLT AC TUNGSTEN HALOGEN LENS

DCB-10	150 Watt Lamp		250 Watt Lamp	
Rotating Speed	Effective Intensity	Nominal Range	Effeceotive Intensity	Nominal Range
1 RPM	22000	16.1	24200	16.3
2 RPM	14600	15.1	16900	15.5
3 RPM	11000	14.5	12900	14.8
4 RPM	8800	14.0	10500	14.4
5 RPM	7300	13.6	8800	14.0
6 RPM	6300	13.2	7600	13.6

DCB-10 WITH 120 V AC METAL HALIDE LAMP

3 RPM	62000	19.0
6 RPM	41000	18.0

EFFECTIVE INTENSITY NON STANDARD LANTERNS (CANDELAS)

155 mm Acrylic Lens with Xenon Light

colour	flash per second	per 4 seconds
red or green	18 candelas	23 candelas

CAK-14 (Projecteur Range light) Flood Light

250 watt	Sodium Vapour Light	14000 candelas
400 watt	Mercury Vapour Frosted	16000 candelas

Keene PHA (Projecteur Range Light)

400 watt	Mercury Halide Lamp	11000 candelas

Chance Brothers 1st ORDER

2.6 RPM	3 Panel	1000 watt Quartzline Lamp	421950candelas

PROCEDURES MANUAL FOR DESIGN AND REVIEW OF MARINE SHORT-RANGE AIDS TO NAVIGATION SYSTEMS (TP9677)

REVISION N° 02

Date: November 29, 1993

List of Corrections.

Page 2-9
Paragraph (9)

After: Current tables
Add: charts

Page 5-3
First line

After: according
Add: to

Page 5-10
Paragraph (a)

After: This would be the combined (summed) frequency of the highest wind speed blowing from
Delete: within 45° on either side of the landfall path toward the horn
Substitute: a 135° sector toward the horn, made up of the 45° quadrant representing the direction of the horn and the 45° quadrants on either side

Page 6-13
Paragraph (a)

Correct as Page 5-10, paragraph (a)

Page B-5

Delete: Local Commercial Vessels (Category II)
Substitute: Uncertified Commercial Vessels (Category II)

Page C-9

Correct example 1. as follows:

σ_1 = (12m x 1½%) σ_2 = (12m x 1½%)

$$R = \sqrt{(12 \times 0.015)^2 + (12 \times 0.015)^2}$$

$$= 0.26 \text{ nautical miles}$$

Correct example 2. as follows:

Range error: $\sigma_1 = 24 \times 1.5\%$

$$= 0.36 \text{ nautical miles}$$

Since 0.36′ is greater than 0.037′ (70 meters), use 0.36 n.m. as the range error for this example.

Page C-10
Bottom of page

Correct the example as follows:

Combining errors: Range error - σ_1 = 0.36 n.m.
Bearing error - σ_2 = 1.26 n.m.

$$R = \sqrt{\sigma_1^2 + \sigma_2^2}$$

$$= \sqrt{0.36^2 + 1.26^2}$$

$$= \sqrt{0.130 + 1.59}$$

$$= 1.31 \text{ nautical miles}$$

ASSUMPTIONS, PRINCIPLES AND GUIDELINES

NOTE: The following statements are to be considered when designing or reviewing marine short-range aids to navigation systems. Some of these statements are contained in the Procedures Manual TP9677, most are proposed for inclusion in the next edition.

GENERAL:

1. The design or review of an aids to navigation system will be carried out by C.G. officers trained in the procedures, with the use of local knowledge of traffic patterns, vessel types and long-term weather statistics. The analysis requires application of technical and engineering principles of aids to navigation, professional mariners judgement and user consultation.

2. Aids to navigation systems are designed for the least capable mariner using the waterway. Thus landfalls are designed for the uncertified mariner with the least accurate or reliable on-board navigation equipment since the main factor affecting landfall design is the accuracy of the navigator. The same principle requires confined-water aids to navigation systems to be based on the largest vessel, since manoeuvrability is the main factor affecting the design.

3. Aids to navigation are not provided as a back-up to failure of the on-board navigational aids (e.g. radar, Loran C.) of certified commercial users.

4. Pleasure craft users will normally be provided with visual aids only.

5. The quantities given in the Preliminary Threat Rating form are guidelines only, to assist in rating the threats to the mariner. They represent a consensus of opinion by C.G. professional mariners and a survey of representatives of the various user groups. These quantities do not represent a go or no-go situation.

6. Although only a few charts have tracks showing the intended route, for purposes of utilizing the aids to navigation system, the analyst must apply tracks to each chart for analysis purposes and design/review the aids system in relation to that track. All off-track aids are to be viewed as falling under the Private Buoy (Aids to Navigation) Regulations, or as isolated hazards with consideration for marking by C.G. If it is felt necessary by the

District/Region office, they may have the tracks applied to CHS charts to identify what route the aids system was designed for.

7. In the absence of guidelines for the selection of buoys, lanterns, Racons, etc. analysts shall ensure that complete local knowledge and experience is used to make these selections. (Some information is available from AMADD).

8. In the absence of a costing and resource utilization model for aids to navigation, the selection of the most cost-effective design option shall be made by the local C.G. District/Region. The impact of any design options on C.G. resources shall also be judged locally.

9. Levels of Service statements will be developed for each site which will be stated in terms that the mariner can understand. Examples are contained in the attached draft of Guidelines for Development of Short-Range Marine Aids to Navigation Level of Service (L.O.S.) Statements for any Waterway. These statements may be used during user consultation and may be included in related marine publications.

LANDFALL:

10. Certified commercial vessels will use on-board navigational aids to make their landfall. Short-Range aids to navigation for landfall will be provided for these users only when there are no distinctive features to support radar/visual landfall or where there are relevant hazards in the vinicity of the landfall. Minor distinctive landfall lights and/or Racons may be provided to confirm/assist landfall for the certified commercial user.

11. Short-Range aids to navigation landfall systems are normally provided for uncertified commercial or pleasure craft users only and are designed with the assumption that the mariner can estimate his position by dead-reckoning using a compass, to an accuracy of 10% of the distance travelled from the last position fix. A maximum landfall distance of 10 nautical miles is used for design purposes. Further landfall distances should be attempted only with long-range on-board navigational equipment, or during clear weather when visibility levels allow the light to be seen at a range equal to at least 10% of the landfall distance to be travelled.

12. It is internationally accepted that sound is a poor aid to navigation in terms of accuracy for establishing a line of position or direction and should be considered primarily as a warning device. This argument is accepted in most part today because the vast majority of commercial fishermen who must

navigate under reduced visibility conditions are equipped with on-board navigational aids such as Radar and Loran C. This is not the case for a large number of in-shore fishermen in Nfld. These fishermen in the small, open boat must rely on their dead-reckoning skills and are very dependant on aural aids to navigation to lead them to a visual reference and to warn of dangers.

13. High-powered distinctive aural signals (fog horns) for direction, are provided to assist landfall, only for the uncertified commercial vessels who may or may not have radar and a certified master; and normally only when the option of offshore sound buoys, either alone or in conjunction with short-range fog signals on shore, is not feasible or cost-effective.

14. Aural signals on relevant hazards shall include bells, whistles and fog-horns on buoys used to warn of hazards such as shoals, breakwaters, a pier or wharf, or the buoy itself. These are normally provided for uncertified commercial users only however, in special circumstances when a lighted buoy is justified for other users, the addition of an aural device may be justified.

15. When designing or reviewing a landfall system of aids, the nominal range of aural signals on buoys is estimated at ½ nautical mile. This is used to assist in determining the spacing requirements when the design option includes offshore buoys to cover the landfall gate.

16. When a landfall light has been inadvertently extinguished there is the possibility of a vessel running aground in the danger area of the landfall gate, when the vessel is ahead of its dead-reckoned, estimated circle of error. A light buoy marking the danger zone is a good precaution, but since we do not design-in redundancy, the coverage of any lighted buoys provided within the landfall perception (P) requirement is used to complement the size of the landfall light.

17. A mariner estimating the luminous range of a light too high, has in principle the same effect as under-estimating the navigational error. However, it is less dangerous than estimating too low because the navigator should notice that the light is not sighted on time and this should cause him to take precautions such as sounding, reduced speed, keeping a better lookout, standing off, etc.

    (It is very important to identify the nominal range of a light with accuracy when reviewing/designing a landfall system. Nominal ranges in the Lists of Lights must be verified against the actual equipment.)

CONFINED WATERS:

18. When designing an aids to navigation system for visual piloting by certified commercial users, usually a confined water or secondary landfall situation, it is assumed that the dead-reckoning accuracy of the vessel, based on gyro or standard compass, will be within 5% of the distance travelled from the last position fix.

19. When designing or reviewing a confined channel for use by large commercial vessels, it is to be noted that when centreline ranges are required as markers for indication of lateral motion, and buoys are also required to identify the outer limits or boundary of the channel to allow vessels to meet/pass; the following guidelines shall be used:

    - When ranges are visible ahead, at least one buoy (on starboard side) should be visible ahead to allow judgement of how far the vessel may safely move off centreline when meeting another vessel.
    - When the ranges are not visible ahead, two buoys (on starboard side) should be visible ahead to allow the vessel to judge its heading more accurately.

20. Where certified commercial vessels are allowed to proceed, and will normally do so, when the meteorological visibility is lower than the visual design level of service, the system shall be designed to provide adequate radar targets/signals, using some of the guidelines in the manual but mostly professional judgement and local knowledge.

21. In the absence of C.G. standards the following guidelines are used:

    - for marking turns; USCG manual;
    - range design; IALA recommendations;
    - visual and radar range of buoys & radar reflectors, use guidelines in manual and professional judgement; and
    - buoy spacing in confined channels; use Rideau River as guideline (summary available from AMADD), for pleasure craft; and 4 to 5 times the channel width for commercial channels, taking design visibility levels into consideration.

22. Although a District/Region may not use light reflective material on aids, the site analysis should recognize the option of reflective material vs. lights, particularly in pleasure craft channels.

23. A number of design assumptions or principles have recently been put forward by International Authorities and have not been compared with, or included in, our design/review manual

or current studies. If future development work is allowed, the following is an example of some of these design principles that could be adopted for commercial channels:

- When large course changes are inevitable, channel curves should permit radial steering. A single curve is better than a sequence of smaller curves at close intervals. Radial steering necessitates that channel curves be well marked in such a way that position control is possible without time consuming plotting.

- Curves should have a centreline radius of at least 5 times the length of the largest vessel, preferably 10 times and more.

- Intermediate straight reaches between curves should have a length of at least 10 times the length of the largest vessel if possible.

- Narrow passages (bridges etc.) in the course of channels necessitate a well marked, straight steering line of at least 5 times the length of the largest vessel on both sides.

- Opportunities for leaving the channel should be provided from place to place, especially for long channels and heavy traffic so that a disabled ship can clear the channel as soon as possible.

- The nominal width of a one-way channel should not be smaller than 5 times the beam of the largest vessel. Under adverse conditions, particularly cross currents, the width should be increased accordingly.

- Whereas it is possible with leading lights (ranges) to assess the leeway of a ship, this is not possible with direction lights.

- Unlighted aids in major shipping channels may be a hazard or at least not contributing to nighttime navigation safety.

- Navigation at bends is a primary area of concern. "Too wide of a turn" is a frequent term appearing in casualty reviews.

DRAFT FEB 18/91

DEVELOPMENT OF LEVELS OF SERVICE (L.O.S.) STATEMENTS FOLLOWING MARINE AIDS CYCLICAL REVIEW

After the Coast Guard District/Region has reviewed an aids to navigation site and approved the design, the level of service provided by the aids to navigation should be stated in a manner that all users and auditors can understand.

The following is a guideline to the preparation of level of service statements followed by an example. None of the following implies C.G. policy regarding the aids needed by any category of user. The need for aids is covered by policy element and the system design manual. The objective of an L.O.S. statement is to describe the aids to navigation system at a site and identify the environmental conditions under which the aids meet the users needs and conversely, under what conditions they may not meet their needs.

Each statement may be conveyed to the public through an update to the C.H.S. Sailing Directions and Small Craft Guides.

These guidelines are in the form of a check-off list only and other important, site specific or unique features of the aids system should be included in the L.O.S. statement for the site.

GUIDELINES FOR DEVELOPMENT OF SHORT-RANGE MARINE AIDS TO NAVIGATION LEVEL OF SERVICE (L.O.S.) STATEMENTS FOR ANY WATERWAY

The following describes the marine short-range aids to navigation service provided by the Canadian Coast Guard at _____ from _____ to _____.

GENERAL:

1. The aids to navigation at this site are provided to mark or warn of underwater hazards to a maximum depth of ____ metres, chart datum. Mariners are to make use of charts and tide tables and take wave heights into consideration to ensure safe underkeel clearance.

2. The deepest draft vessels presently known to use this channel safely have a draft of _____ metres.

3. The aids to navigation system at this site is designed to support landfall by uncertified vessels until visibility is reduced to _____ nautical miles.

4. The aids to navigation system in the confined waters of this site is designed to assist navigation by (enter category of user) until visibility is reduced to _____ n.m.

5. When visibility is reduced and some aids are not visible at the distance required for safety, navigation is supported by:

   - aural signals
   - radar targets/signals
   - no aural or radar aids, vessels may be at unacceptable risk in reduced visibility and should not proceed without local knowledge if safe anchorage is available.

CERTIFIED COMMERCIAL VESSELS (vessels with radar and standard compass as per Navigation Appliances Equipment regulations and standards, operated by a certified mariner).

A. Landfall - Open Water:

Landfall by certified commercial vessels is to be made with the use of on-board navigational aids such as Loran C and Radar. Landfall aids to navigation systems are primarily designed for the least capable user; the uncertified mariner using only a non-standard compass.

1. Daytime landfall at this site may be assisted or confirmed by:

   - Land based or fixed daymark, L.L. # _____
   - Buoy(s) # _____ marking relevant hazards
   - Buoy(s) # _____ marking fairway or pilot boarding station
   - Buoys # _____ providing good radar target.
   - Racon on buoy # _____.
   - Racon on fixed structure, L.L. _____.
   - Local knowledge, visual and/or radar distinctive landmarks.

2. Nighttime landfall at this site may be assisted or confirmed by:

   - Land-based or fixed light(s) L.L. # _____.
   - Light(s) on buoy(s) # _____ marking hazards.
   - Light(s) on buoy(s) # _____ marking the fairway or pilot boarding station.
   - Radar targets and/or Racons as above.
   - Local knowledge, visual and/or radar distinctive landmarks.

B. Confined Waters:

1. Daytime navigation at this site is supported by:

   - Buoys marking relevant hazards or boundary of channel.
   - Buoys marking turns
   - Fixed structures marking relevant hazards
   - Fixed structures marking turns
   - Ranges marking the centreline of the channel.
   - Buoys providing good radar targets.
   - Racons located at _____.
   - Local knowledge only.

2. Nighttime navigation at this site is supported by:

   - Land based or fixed light(s), L.L. No(s) _____
   - Lights on buoys.
   - Lights on ranges.
   - Radar targets and/or Racons as above.
   - Light reflective material on buoys.
   - Light reflective material on fixed structures.
   - Local knowledge only.

PLEASURE CRAFT AND/OR UNCERTIFIED COMMERCIAL VESSELS

A. Landfall - Open Water

The landfall system at this site is designed to provide coverage for landfall by a mariner navigating by dead-reckoning, using a non-standard compass from a maximum distance of _____ miles.

1. Daytime landfall at this site is supported by:

- Land-based or fixed distinctive daymarks.
- Buoy(s) # _____ marking hazards
- Buoy # _____ marking the entrance or fairway.
- Fog signal on shore for general direction.
- Fog signal on shore as hazard warning only.
- Aural signals (Bells, Whistles, etc) on buoys.
- Local knowledge only.

2. Nighttime landfall at this site is supported by:

- Land-based or fixed distinctive light # _____
- Lights on buoy(s) # _____ marking hazards.
- Lights on buoy # _____ marking the entrance or fairway.
- Light reflective material on buoy(s) # _____.
- Aural signals as identified above.
- Local knowledge only.

B. Confined Waters

1. Daytime navigation in the confined waters of this site is supported by:

- Buoys and/or fixed structures marking relevant hazards.
- Buoys and/or fixed structures marking turns.
- Range markers aligned with the centreline of the channel.
- Local knowledge only.

2. Nighttime navigation at this site is supported by:

- Lights on fixed structures.
- Lights on buoys # _____ to # _____.
- Reflective material on fixed structures (daybeacons).
- Reflective material on buoys.
- Lights on ranges.
- Local knowledge only.

EXAMPLE - MAJOR COMMERCIAL HARBOUR, ALSO USED BY FISHING VESSELS AND PLEASURE CRAFT.

The following describes the aids to navigation service provided by the Canadian Coast Guard at No name Harbour main channel from open sea to Big Island.

1. Aids to navigation at this site are provided to mark or warn of hazards to a maximum depth of 20 metres, chart datum. Mariners are to make use of charts and tide tables and take wave heights into consideration to ensure safe under keel clearance.

2. The deepest draft vessels presently known to be using this channel have a 15 metre draft.

3. The visual aids to navigation system at this site is designed to support landfall by uncertified vessels until visibility is reduced to 1 nautical mile and navigation by certified commercial vessels in the confined waters until visibility is reduced to ½ n.m.

4. When visibility is reduced and some aids are not visible at the distances required for safety at reduced vessel speed, movement is supported by aural signals, radar targets and racons.

CERTIFIED COMMERCIAL VESSELS:

Landfall by certified commercial vessels is to be made with the use of on-board navigational aids. The landfall system is designed primarily for uncertified vessels however, commercial vessels may confirm landfall with Long Pt. Lightstation L.L. # 122 and light and whistle fairway buoy # HA which is also equipped with a Racon and marks the pilot boarding station.

The confined channel is well marked by lighted centreline ranges and lighted buoys which are good radar targets. All turns are marked by buoys with quick flashing lights.

PLEASURE CRAFT AND UNCERTIFIED COMMERCIAL VESSELS:

Landfall at this site is supported by Long Point Lightstation #122 which is a 60 metres high tower with red and white horizontal bands with a red and white building adjacent to it. The lightstation also has a fog alarm which is set to operate automatically when visibility is reduced to 2 nautical miles. This signal is designed to provide general direction in fog until the lightstation or lighted fairway buoy #HA is visible. The fairway buoy is equipped with a whistle activated by sea swell. The horn and buoy whistle provide good coverage for anyone making a dead-reckoning landfall by non-standard compass from a distance of up to 10 miles, until on-shore wind exceeds 4 knots. When wind against the horn exceeds this speed, the range of the sound will be severely reduced.

Landfall at this site, over greater distances should be supported with on-board, long-range navigational aids, and at night, only when visibility levels allow the light to be seen at a range equal to at least 10% of the landfall distance to be travelled. The nominal range diagram in the List of Lights, Atlantic Coast, can be used to determine the range of the landfall light under the prevailing visibility levels.

The main channel into the harbour is designed for large commercial vessels and smaller vessels may enter the harbour by any route. All relevant hazards outside the main channel are marked with cardinal or isolated danger buoys. These buoys do not carry bells or whistles or lights and vessels outside the main channel must exercise caution in reduced visibility. The buoys are equipped with light reflective material to allow nighttime visibility and identification with the use of a searchlight.

A hand held light (3 watt bulb, 6 volt battery) will allow buoy identification at approximately 400 yards on a clear night. A boat mounted spot light (of 75,000 cd) will allow buoy identification at 800 yds.

COMMERCIAL VESSEL OPERATORS

EXPERT OPINIONS

1. Commercial Mariners will proceed under restricted visual conditions, at a speed that will allow them to stop at 1/2 the meteorological visibility condition; e.g. at 1/2 mile visibility, a vessel will proceed at a speed that will allow him to stop at 1/4 mile.

2. Unlighted buoys alternated with lighted buoys in a marked channel constitute anything from a nuisance to a menace unless they are radar conspicous. Being able to see the buoys ahead further at night than daytime is more acceptable than adding unlighted buoys to increase the level of service for daytime navigation.

3. The seaward side of harbour entrance channels require the installation of an approach buoy at least one mile from the channel entrance to permit vessel/channel alignment prior to entrance.

4. Long range lights within a harbour complex are rarely used as all-around aids and may have a blinding effect on navigation passing close. They are used if part of a range or as a single-point steering guide.

5. Sound signals from aids are not used.

6. Aids astern are not frequently used, unless there is a lack of aids ahead.

Draft
May 19, 1993

DISCUSSION PAPER

ASSESSMENT OF COMMERCIAL OPERATORS' NEEDS FOR LIGHTED AIDS IN CONFINED WATERS

1. The directives and design manual procedures are not specific enough to make every decision for every waterway with regard to the need of certified commercial vessels for lighted aids in confined waters, as opposed to reflective material used with a searchlight on the vessel.

2. The main intent of our design quidelines is; that Coast Guard now accepts that certified commercial vessels, can make their own landfall using on-board navigational aids. They do not need a short-range aids landfall system with a major light and aural signals, as they did in the past.

   User consultation has confirmed that commercial vessels no longer use or need such landfall systems. There is provision however, to provide confirmation of landfall with a minor distinctive light in some areas.

3. It was also intended to make it clear that large unmanoeuvrable commercial vessels could not be expected to transit most confined waters such as the seaway, with only reflective material on buoys and a searchlight on the vessel.

   There are no hard and fast rules to direct such an analysis, only guidelines which may result in a decision to use either lights or reflective material. For example:

   a) Commercial I vessels are provided with lights in the Seaway.

   b) Commercial I vessels in the MacKenzie River use searchlights and aids have reflective material.

   In each situation it is the relative size of the vessel to the channel, local knowledge of the waterway, etc., that allows the diversity, as well as the cost of providing the service.

.../2

4. The situation described in Laurentian seems to be a question of; are certified commercial tour vessels able to make use of reflective material on aids rather than lighted aids with a searchlight on-board, to transit a confined channel safely at night?

   When analyzing/reviewing such a situation, the major point should be whether or not the users are relatively manoeuvrable in relation to the channel in question and if traffic justifies the cost. Refer to the following for some guidelines:

   a) Directive 2.2200 Design of Short-Range Marine Aids Systems

      4.7.3. Hours of Darkness: Lighted aids to navigation will be provided where necessary to assist Category I vessels in transit channels and to reach safe anchorage in the inner approaches, but will be provided on the remaining sections of inner approaches only where loading and unloading normally occurs during hours of darkness and there is sufficient volume of traffic to justify the cost.

   b) Preliminary Threat Rating (73-0118), example:

      - A 65′ to 100′ vessel in a 400′ channel, with no turns greater than 20°, with infrequent (<10%) wind speed over 15 knots or wave height over 0.5 metres, in a cross-current less than 1 knot, along track current less than 3 knots, with visibility better than 2 miles 85% of the time.

      Such a vessel in such a waterway should be considered as manoeuvrable.

5. Before considering the use of reflective material or lighted aids for category I vessels in confined waters, these 2 guidelines mentioned above, should be considered in conjunction with user consultation, local Coast Guard knowledge and professional judgement. If reflective material is provided, users should be advised of the need for searchlights and that a hand held light (3 watt bulb, 6 volt battery, 4,000 candelas) will allow buoy identification at approximately 400 yards on a clear night and that a buoy mounted spotlight of 75,000 cd will allow buoy identification at 800 yards.

.../3

6. When an aids to navigation system is provided in a waterway, there are two level of service decisions that must be made in response to the following questions:

a) Who is the service for? (LOS of extent).

b) How much service should be provided? (LOS of quantity).

The first question relates to our Provision Directive 2.2100 which is presently under revision in support of the Strategic plan. This directive is the guideline that specifies the conditions under which short-range marine aids services may be established or discontinued.

The second question relates to the Design Directive 2.2200 which identifies the principles and procedures for the design of a system that meets the establishment criteria under Directive 2.2100.

Under the provision policy, service would not be justified for a category of user where the numbers of users were too few to have the benefits outweigh the costs of the service. There are some guidelines in the directive which require the Regional office to gather the traffic data and complete a system design. This will then allow the basis for a decision on benefits v.s. costs by the Regional Aids Managers with assistance from the Economic Evaluation Group (AFE).

Since the design criteria focuses on the least capable mariner by both category and size; (e.g. Cert. I commercial don't need landfall aids because they are capable of making landfall using onboard navigational aids thus landfall is only provided for Cat. II or III users, and; the largest vessels in the category is the basis for confined water system designs because they are the least capable in terms of manoeuvrability), the decision as to whom the system is designed for must focus on both, category, and, size of users.

In a confined water situation it is obvious that a system designed for large unmanoeuvrable commercial vessels would probably result in a system of lighted aids, particularly where there is heavy volume of 2 way traffic who need to travel at night and the benefits of supporting the nighttime traffic outweigh the costs. Small vessels in other categories could then make use of such a system even though it is not designed for them or justified by them in terms of benefits/costs.

.../4

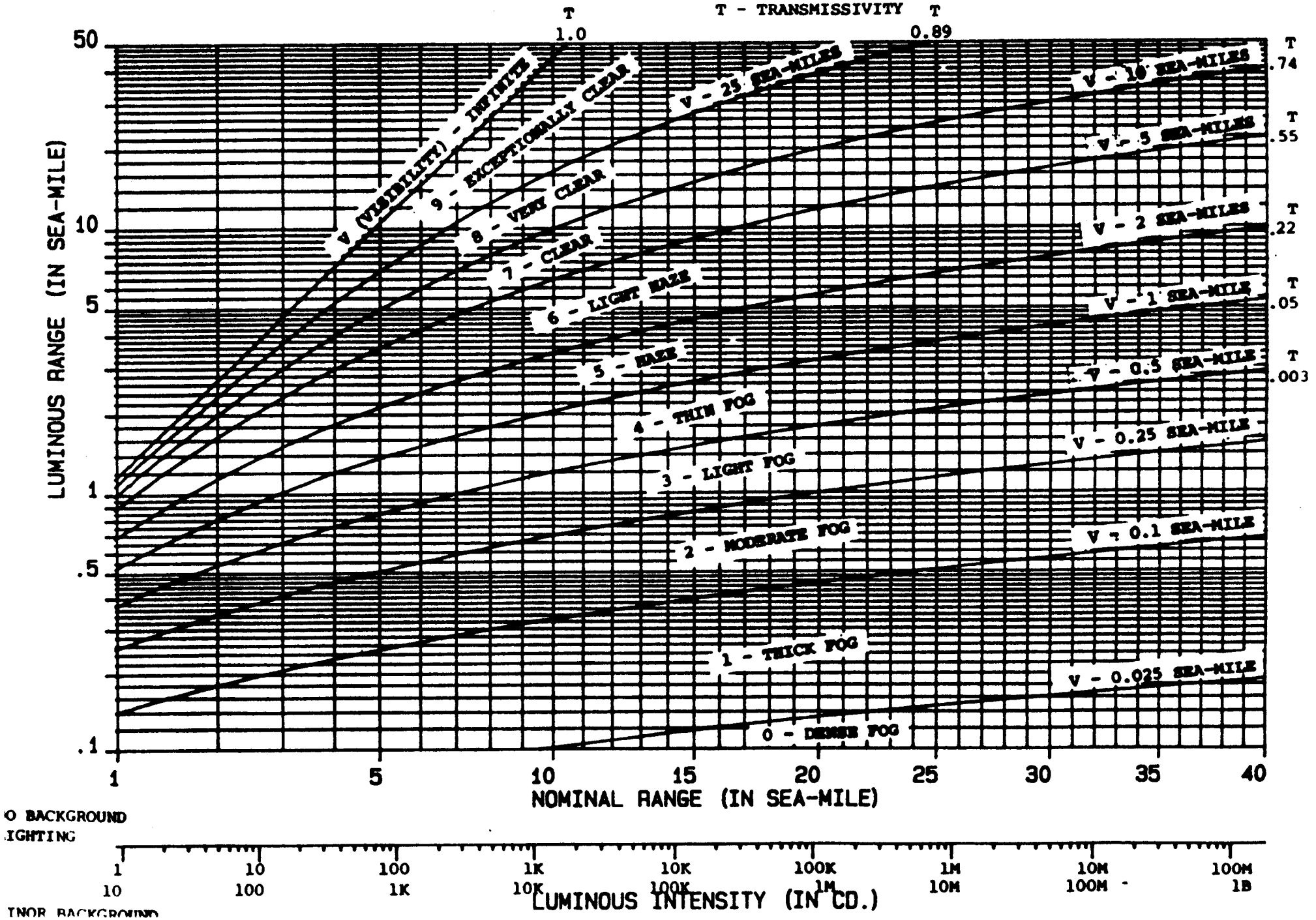
On the other hand, a confined water system of aids established for relatively small pleasure craft, because the benefit to the number of pleasure craft outweigh the costs of the service, may not meet the needs of a large unmanoeuvrable commercial vessel. The system may meet the needs of the pleasure craft caught out after dark, by using retroreflective material that can be located with flashlight or searchlight. A large unmanoeuvrable vessel may not be able to react quickly enough to use the system at night, with a searchlight. Unless the number of such commercial vessels justified the extra cost of a lighted system, there would be no support for a Coast Guard decision to provide such a lighted service.

If a commercial vessel is capable of nighttime navigation in a confined channel with only reflective material, as aids to navigation because it is equipped with an adequate searchlight, there would be no reason to redesign the aids system, although the system should be reviewed against the directives on reflective material, A31 and A3, and in consultation with the user(s) in question.

CONVERSION TABLE FOR INTENSITY & NOMINAL RANGE TO LUMINOUS RANGE UNDER VARIOUS VISIBILITIES

INTEN-SITY (CD)	NOMINAL RANGE	VISIBILITY											
		5.5 VIS.	5.0 VIS.	4.5 VIS.	4.0 VIS.	3.5 VIS.	3.0 VIS.	2.5 VIS.	2.0 VIS.	1.5 VIS.	1.0 VIS.	0.5 VIS.	0.25 VIS.
0.9	1.0	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.3
2.4	1.5	1.3	1.3	1.2	1.2	1.1	1.1	1.0	0.9	0.8	0.7	0.5	0.3
5	2.0	1.7	1.6	1.6	1.5	1.5	1.4	1.3	1.1	1.0	0.8	0.5	0.3
9	2.5	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.3	1.1	0.9	0.6	0.4
15	3.0	2.4	2.3	2.2	2.1	2.0	1.9	1.7	1.5	1.3	1.0	0.7	0.4
24	3.5	2.8	2.7	2.5	2.4	2.3	2.1	1.9	1.7	1.4	1.1	0.7	0.4
36	4.0	3.1	3.0	2.8	2.7	2.5	2.3	2.1	1.8	1.5	1.2	0.8	0.5
53	4.5	3.4	3.3	3.1	2.9	2.7	2.5	2.3	2.0	1.7	1.3	0.8	0.5
77	5.0	3.8	3.6	3.4	3.2	3.0	2.7	2.4	2.1	1.8	1.4	0.8	0.5
108	5.5	4.1	3.9	3.7	3.4	3.2	2.9	2.6	2.3	1.9	1.4	0.9	0.5
149	6.0	4.4	4.2	4.0	3.7	3.4	3.1	2.8	2.4	2.0	1.5	0.9	0.5
203	6.5	4.7	4.5	4.2	3.9	3.6	3.3	2.9	2.5	2.1	1.6	1.0	0.6
274	7.0	5.1	4.8	4.5	4.2	3.8	3.5	3.1	2.7	2.2	1.7	1.0	0.6
365	7.5	5.4	5.1	4.7	4.4	4.1	3.7	3.3	2.8	2.3	1.7	1.0	0.6
482	8.0	5.7	5.3	5.0	4.6	4.3	3.9	3.4	2.9	2.4	1.8	1.1	0.6
632	8.5	6.0	5.6	5.3	4.9	4.5	4.0	3.6	3.1	2.5	1.9	1.1	0.6
824	9.0	6.3	5.9	5.5	5.1	4.7	4.2	3.7	3.2	2.6	1.9	1.1	0.7
1070	9.5	6.6	6.2	5.8	5.3	4.9	4.4	3.9	3.3	2.7	2.0	1.2	0.7
1370	10.0	6.9	6.5	6.0	5.6	5.1	4.6	4.0	3.4	2.8	2.1	1.2	0.7
1760	10.5	7.2	6.7	6.3	5.8	5.3	4.7	4.2	3.5	2.9	2.1	1.2	0.7
2240	11.0	7.5	7.0	6.5	6.0	5.5	4.9	4.3	3.7	3.0	2.2	1.3	0.7
2840	11.5	7.8	7.3	6.8	6.2	5.7	5.1	4.5	3.8	3.1	2.2	1.3	0.7
3600	12.0	8.1	7.5	7.0	6.5	5.9	5.3	4.6	3.9	3.1	2.3	1.3	0.8
4530	12.5	8.4	7.8	7.3	6.7	6.1	5.4	4.7	4.0	3.2	2.4	1.4	0.8
5700	13.0	8.6	8.1	7.5	6.9	6.3	5.6	4.9	4.1	3.3	2.4	1.4	0.8
7130	13.5	8.9	8.4	7.7	7.1	6.5	5.8	5.0	4.2	3.4	2.5	1.4	0.8
8910	14.0	9.2	8.6	8.0	7.3	6.6	5.9	5.2	4.4	3.5	2.5	1.5	0.8
11100	14.5	9.5	8.9	8.2	7.5	6.8	6.1	5.3	4.5	3.6	2.6	1.5	0.8
13800	15.0	9.8	9.1	8.5	7.8	7.0	6.3	5.4	4.6	3.7	2.7	1.5	0.9

INTEN-SITY (CD)	NOMINAL RANGE	VISIBILITY											
		5.5 VIS.	5.0 VIS.	4.5 VIS.	4.0 VIS.	3.5 VIS.	3.0 VIS.	2.5 VIS.	2.0 VIS.	1.5 VIS.	1.0 VIS.	0.5 VIS.	0.25 VIS.
21200	16.0	10.4	9.7	8.9	8.2	7.4	6.6	5.7	4.8	3.8	2.8	1.6	0.9
32300	17.0	11.0	10.2	9.4	8.6	7.8	6.9	6.0	5.0	4.0	2.9	1.6	0.9
48800	18.0	11.5	10.7	9.9	9.0	8.2	7.2	6.3	5.2	4.2	3.0	1.7	0.9
73400	19.0	12.1	11.2	10.4	9.5	8.5	7.5	6.5	5.5	4.3	3.1	1.7	1.0
110000	20.0	12.7	11.8	10.8	9.9	8.9	7.9	6.8	5.7	4.5	3.2	1.8	1.0
163000	21.0	13.2	12.3	11.3	10.3	9.3	8.2	7.1	5.9	4.7	3.3	1.9	1.0
242000	22.0	13.8	12.8	11.8	10.7	9.6	8.5	7.3	6.1	4.8	3.4	1.9	1.1
357000	23.0	14.4	13.3	12.2	11.1	10.0	8.8	7.6	6.3	5.0	3.5	2.0	1.1
524000	24.0	14.9	13.8	12.7	11.6	10.4	9.1	7.9	6.5	5.1	3.7	2.0	1.1
767000	25.0	15.5	14.4	13.2	12.0	10.7	9.4	8.1	6.7	5.3	3.8	2.1	1.1
1120000	26.0	16.1	14.9	13.6	12.4	11.1	9.8	8.4	7.0	5.5	3.9	2.1	1.2
1630000	27.0	16.6	15.4	14.1	12.8	11.5	10.1	8.7	7.2	5.6	4.0	2.2	1.2
2360000	28.0	17.2	15.9	14.6	13.2	11.8	10.4	8.9	7.4	5.8	4.1	2.2	1.2
3420000	29.0	17.8	16.4	15.0	13.6	12.2	10.7	9.2	7.6	5.9	4.2	2.3	1.2
4940000	30.0	18.3	16.9	15.5	14.0	12.5	11.0	9.4	7.8	6.1	4.3	2.4	1.3


T - TRANSMISSIVITY
T
1.0
T
0.89
V (VISIBILITY) - INFINITE
9 - EXCEPTIONALLY CLEAR
8 - VERY CLEAR
7 - CLEAR
6 - LIGHT HAZE
5 - HAZE
4 - THIN FOG
3 - LIGHT FOG
2 - MODERATE FOG
1 - THICK FOG
0 - DENSE FOG
V - 10 SEA-MILES
V - 5 SEA-MILES
V - 2 SEA-MILES
V - 1 SEA-MILE
V - 0.5 SEA-MILE
V - 0.25 SEA-MILE
V - 0.1 SEA-MILE
V - 0.025 SEA-MILE
T .74
T .55
T .22
T .05
T .003
LUMINOUS RANGE (IN SEA-MILE)
50
10
5
1
.5
.1
1
5
10
15
20
25
30
35
40
NOMINAL RANGE (IN SEA-MILE)
O BACKGROUND
IGHTING
1
10
10
100
100
1K
1K
10K
10K
100K
100K
1M
1M
10M
10M
100M
100M
1B
LUMINOUS INTENSITY (IN CD.)
INOR BACKGROUND