ATTACHMENT

ATTACHMENT OF SUPPLEMENTAL INFORMATION TO SEASTAR EXPERIMENTAL LICENSE RENEWAL

Pursuant to Part 5 (Experimental Radio Services), Title 47 (Telecommunication) of the U.S. Code of Federal Regulations, Orbital Sciences Corporation ("Orbital" or "OSC"), on behalf of its wholly owned subsidiary Orbital Imaging Corporation ("ORBIMAGE") submits this renewal application for operating the OSC controlled radio links necessary for supporting the SeaStar™ program. Orbital is an aerospace and telecommunications technology company, incorporated in the state of Delaware, and headquartered at 21700 Atlantic Boulevard, Dulles, Virginia, 20166.

Currently, the SeaStar program is licensed for experimental operations under file numbers 4542-EX-PL-94 and 4243-EX-PL-94. Both expire on 01 January 1999 at 3:00am EST. This single application seeks renewal of both licenses for continued operation of the SeaStar system.

The launch vehicle for SeaStar is the OSC owned and developed Pegasus XL. Pegasus is a privately developed winged rocket launched from the OSC owned L-1011 launch aircraft.

The SeaStar System consists of 4 major parts: 1) the SeaStar satellite; 2) the satellite payload consisting of the Sea Viewing Wide Field-of-View Sensor (SeaWiFS); 3) the OSC owned and operated Ground Segment consisting of the Spacecraft Operations Control Center (SOCC) and West Virginia Remote Tracking Station (RTS) for Telemetry, Tracking, and Commanding activities (TT&C); and 4) worldwide NASA and OSC owned ground data reception facilities.

This application, under Part 5 (Experimental Radio Services), is for the Telemetry, Tracking, and Commanding (TT&C) S- and L-Band radio links and for the L-Band Mission Data Recovery direct downlink necessary for supporting the SeaStar spacecraft and its mission.

LICENSED SeaStar FREQUENCY PLAN

Link	*Frequency*	*Band*	*Operational Rqt*
earth-to-space	2092.59 MHZ	S	telecommand
space-to-earth	1702.5 MHZ	L	telemetry/real-time mission data

Current Particulars of Operation

Space-to-Earth Telemetry Link/Real-Time Mission Data Link

Hi Data Rate L-Band Link Budget Analysis - Page A
Low Data Rate L-Band Link Budget Analysis - Page B
Hi Data Rate L-Band Link Budget Analysis to Various Receive Only Earth Stations - Page D1-D2

Earth-to-Space Telecommand Link

S-Band Link Budget Analysis - Page C

TABLE 5.0 SEASTAR SPACECRAFT TO OSC GROUND STATION, WEST Va. - L BAND DATA RF LINK 665.4 Kbps HRPT
NADIR BORESIGHT POINTING VIA S/C HIGH GAIN ANTENNA

PAGE:1 REV:01	REVISION DATE:02-08-96	DOC:WS-SSTLXXX-SS S/C TO GND STATION TLM LINK-xxx-RF			
Modulation: PSK/FSK-BiPhase L bps	665000	Demodulator Noise Bandwidth to Data Bit Rate Ratio, Ldem			
SEASTAR SPACECRAFT (SS S/C) TO OSC GROUND STATION - DATA	L BAND TXL 1 OR 2 TO ESLA HI GAIN CA3636	NADIR POINTING	Std:Gcr=?dB err=5.0 Tant=146	Std:Gcr=?dB err=5.0 Tant=146	Std:Gcr=?dB err=5.0 Tant=146
SEASTAR ANT POLARIZATION: RH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Result	1.35183??S/C OVERHEAD	S/C AT HORIZ	S/C OVERHEAD	
		ENTER'S'or ##	S/C Ant Gain @ 0 Deg or Nadir	S/C Ant Gain @ 6	
SS Spacecraft to OSC Ground Station DATA LINK RANGE, km	[yyy.y]	ENTER ##	705.0	2575.0	705.0
Spacecraft Tx Power Output, 5 watt, dBW	Pt	GIVEN VAR	7.0	7.0	7.0
Spacecraft Tx Circuit, Component/Cable Loss, dB	Lct (always negative)	GIVEN VAR	-1.7	-1.7	-1.7
Spacecraft Transmit Antenna Gain, dB	Gt	ENTER ##/WSF	-2.5	-2.5	3.0
SS Spacecraft Tx EIRP, dBW	EIRP=Pt+Lct+Gt	WS FORMULA	2.8	2.5	8.3
Spacecraft Antenna 3 dB Beamwidth, Degrees	Bwt	GIVEN VAR	240.0	240.0	240.0
Spacecraft Telemetry Frequency, MHz	Fc	ENTER ##	1702.5	1702.5	1702.5
Range in km	R yyy.y	WS FORMULA	705.0	2575.0	705.0
Space Loss, dB	Sl=-92.44-20*log(R)-20*log(Fc/1000)	WS FORMULA	-154.0	-165.3	-154.0
Atmospheric Attenuation, dB		ENTER ##	-0.5	-0.5	-0.5
Rain Loss, dB	Crane or Lin Model	ENTER ##	0.0	0.0	0.0
Spacecraft Pointing Error to SS Ground Station, Degrees	ert	ENTER #	5.0	5.0	5.0
Spacecraft Pointing Loss, dB	Lpt=-12*(ert/Bwt)^2	WS FORMULA	0.0	0.0	0.0
SS Ground Station Rx Antenna Polarization/Axial Ratio Loss, dB	Lpa (always negative)	GIVEN VAR	-0.5	-0.5	-0.5
Ground Station Rx Antenna Peak/Boresight Gain, dB	Gr	GIVEN VAR	38.6	38.6	38.6
Ground Station Rx Antenna 3 dB Beamwidth, Degrees	Bwr	ENTER #	1.9	1.9	1.9
SS Ground Station Rx Antenna Pointing Error, Degrees	err	ENTER #	0.2	0.2	0.2
SS Ground Station Rx Antenna Pointing Loss, dB	Lpr=-12*(err/Bwr)^2	WS FORMULA	-0.1	-0.1	-0.1
Total Received Power at SS Ground Station Antenna Output, (Pant), dBW	Pant=EIRP+Sl+Lpt+Lpa+Lpr+Gr	WS FORMULA	-113.8	-125.0	-108.3
SS Ground Station Rx Circuit, Cmpnt/Cable Loss, from Ant Output to First Active Stage: CFG X) to LNA (if installed), or CFG Y) to Xpndr/Receiver, dB	Lcr1 (always negative to 1st stg)	ENTER ##	-2.4	-2.4	-2.4
SS Ground Station RF Low Noise Amplifier, Noise Figure, (if installed), dB	NFlna-del either Cell 728/731 in Row 37 WSFormula	ENTER ##			
SS Ground Station RF Low Noise Amplifier, Gain, (if installed), dB	Glna	ENTER ##			
SS Ground Station Rx Circuit, Cmpnt/Cable Loss, after LNA and prior to Second Stage: CFG Y) to Xpndr/Receiver, dB	Lcr2 (always negative to 2nd stg)	ENTER ##			
Xpndr/Receiver, Noise Figure, dB	NFXpndr/Receiver	ENTER ##	0.9	0.9	0.9
SS Ground Station Overall System Loss from Ant Output to First Active Stage:CFG X) to LNA (if installed) or CFG Y) to Xpndr/Receiver, dB	Lsr (RF loss is negative)	WS FORMULA	-2.4	-2.4	-2.4
SS Ground Station System Loss Factor from Ant Output to First Active Stage	Lr=10^(-Lsr/10)	WS FORMULA	1.7	1.7	1.7
SS Ground Station Overall System Loss/Gain from Ant Output to Xpndr/Rec	Ls3 (RF loss is negative)	WS FORMULA	-2.4	-2.4	-2.4
SS Ground Station Overall System Noise Figure, referred to Ant Output, (product of all cable losses + LNA NF/Gain, if installed, + Xpndr/Receiver NF), dB	NFsys=product of Lcr1+NF1stg+Glna+Lcr2+NF2stg)	WS FORMULA	3.3	3.3	3.3
Ground Station Overall System Noise Factor, referred to Ant Output,(incl X	Fsys=10^(NFsys/10)	WS FORMULA	2.2	2.2	2.2
SS Ground Station Noise Factor at First Active Stage, (LNA or Xpndr/Receiver	F1stg=10^(NF1stg/10)Enter From Row 28 LNA or 31	WS FORMULA	1.2	1.2	1.2
SS Ground Station Antenna Temperature, Degrees K	Tant (dependent on elevation pointing)	ENTER ##	146.0	146.0	146.0
SS Ground Station System Noise Temperature, Degrees K	Ts=Tant/Lr+290*(Lr-1)/Lr+290*(F1stg-1)	WS FORMULA	276.4	276.4	276.4
SS Ground Station System Noise Temperature, dBK	TsdB=10*log(Ts)	WS FORMULA	24.4	24.4	24.4
SS Ground Station G/T at First Active Stage, (LNA or Xpndr/Receiver) input,	G/T=Gr+Lsr-TsdB	WS FORMULA	11.3	11.3	11.3
Boltzmann's Constant, dB W/K/Hz	k=-228.6	GIVEN VALUE	-228.6	-228.6	-228.6
SS Ground Station Noise Spectral Density (No), dB W/Hz	No=-228.6+TsdB	WS FORMULA	-204.2	-204.2	-204.2
Total Power Rcvd.(Pr)/Noise Spectral Density,(No),at Xpndr/Receiver Input, dBHz	(Pant+Lsr)/No=Pant+Lsr-No	WS FORMULA	88.0	76.8	93.5
Residual Carrier Loss, dB	Lcar (always negative)	ENTER #	-0.2	-0.2	-0.2
Demodulation Noise Bandwidth/Data Bit Rate Range Modifier	Ldemod (always negative)	WS FORMULA	-3.0	-3.0	-3.0
Data Modulation Loss, dB (For Modulation Index,TH =1.18 radians	Dl=10*log(2*J1(TH)^2) from Bessel Tables	ENTER #	-0.7	-0.7	-0.7
Data Bit Rate, bps	Rb	WS FORMULA	565000.0	665000.0	565000.0
Data Bit Rate, dBHz	RdB=10*log(Rb)	WS FORMULA	58.2	58.2	58.2
SNR in Bit Rate Bandwidth, (Pr/No), dB	SNR=Pr/No-RdB+Dl+Ldemod+Lcar	WS FORMULA	25.9	2.0	31.4
Theoretical Eb/No for 1 in 10-6 Bit Error Rate	Eb/No	GIVEN VAR	10.7	10.7	10.7
Bit Synch Degradation, dB	Lbs (always negative)	GIVEN VAR	-1.0	-1.0	-1.0
Required Eb/No, dB	Eb/No required=Eb/No-Lbs	WS FORMULA	11.7	11.7	11.7
Required Pr/No, dBHz	Pr/No required=Eb/No required+RdB-Dl-Ldemod-Lcar	WS FORMULA	73.3	73.3	73.5
Data Link Margin, dB	Margin=Pr/No-Pr/No required	WS FORMULA	14.2	2.0	19.7
Or if Data Link Margin Value is x.x dB	[x.x]	ENTER ##	3.0	2.0	0.0
Then Resultant Maximum Range is yyy.yy Km	[yyy.y]	WS FORMULA	[illegible]	2564.4	[illegible]

TABLE 3.0 SEASTAR SPACECRAFT TO OSC GROUND STATION, WEST Va, - L BAND TELEMETRY RF LINK HDLC
NADIR BORESIGHT POINTING VIA S/C HIGH GAIN ANTENNA

PAGE:1 REV:01	REVISION DATE:02-08-96	DOC:WS-SSTLMKX-SS S/C TO GND STATION TLM LINK-...			
Modulation: PSK/NRZ-BiPhase L, bps	57600	Demodulator Noise Bandwidth to Data Bit Rate Ratio, Ldem			
SEASTAR SPACECRAFT (SS S/C) TO OSC GROUND STATION - TELEMETRY	L BAND TXL 1 OR 2 TO ESLA (HI GAIN) CA3636	NADIR POINTING	Std:Gcx=?dB ecrt=5.0 Tant=146	Std:Gcx=?dB ecrt=5.0 Tant=146	Std:Gcx=?dB ecrt=5.0 Tant=146
SEASTAR ANT POLARISATION: RH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Resu	1.8518377	S/C OVERHEA	S/C AT HORIZ.	S/C OVERHE
		ENTER'S or ##	S/C Ant Gain + 0 Deg or Nadir S		S/C Ant Gain -
SS Spacecraft to OSC Ground Station TELEMETRY LINK RANGE, km	(777.7)	ENTER ##	705.0	2575.0	705.
Spacecraft Tx Power Output, 5 watt, dBW	Ptx	GIVEN VAR	7.0	7.0	7.
Spacecraft Tx Circuit, Component/Cable Loss, dB	Ltx (always negative)	GIVEN VAR	-1.7	-1.7	-1.
Spacecraft Transmit Antenna Gain, dB	Gcx	ENTER ##/WS	-2.5	-2.5	3.
SS Spacecraft Tx EIRP, dBW	EIRP=Ptx-Ltx-Gcx	WS FORMULA	2.8	2.8	8.
Spacecraft Antenna 3 dB Beamwidth, Degrees	Bms	GIVEN VAR	240.0	240.0	240.
Spacecraft Telemetry Frequency, MHz	Fc	ENTER ##	1702.5	1702.5	1702.
Range in km	R (777.7)	WS FORMULA	705.0	2575.0	705.
Space Loss, dB	Sl=-92.44-20*log(R)-20*log(Fc/1000)	WS FORMULA	-154.0	-165.3	-154.
Atmospheric Attenuation, dB		ENTER ##	-0.5	-0.5	-0.
Rain Loss, dB	Crane or Lin Model	ENTER ##	0.0	0.0	0.
Spacecraft Pointing Error to SS Ground Station, Degrees	ert	ENTER #	5.0	5.0	5.
Spacecraft Pointing Loss, dB	Lpt=-12*(ert/Bms)^2	WS FORMULA	0.0	0.0	0.
SS Ground Station Rx Antenna Polarization/Axial Ratio Loss, dB	Lpo (always negative)	GIVEN VAR	-0.5	-0.5	-0.
Ground Station Rx Antenna Peak/Boresight Gain, dB	Gr	GIVEN VAR	38.6	38.6	38.
Ground Station Rx Antenna 3 dB Beamwidth, Degrees	Bmr	ENTER #	1.9	1.9	1.9
SS Ground Station Rx Antenna Pointing Error, Degrees	err	ENTER #	0.2	0.2	0.2
SS Ground Station Rx Antenna Pointing Loss, dB	Lpr=-12*(err/Bmr)^2	WS FORMULA	-0.1	-0.1	-0.1
Total Received Power at SS Ground Station Antenna Output, (Pant), dBW	Pant=EIRP+Sl+Lpt+Lpo+Lpr+Gr	WS FORMULA	-113.8	-125.0	-108.
SS Ground Station Rx Circuit, Cmpnt/Cable Loss, from Ant Output to First Active Stage: CFG X) to LNA (if installed), or CFG Y) to Xpndr/Receiver, dB	Lrr1 (always negative to lna)	ENTER ##	-2.4	-2.4	-2.4
SS Ground Station RF Low Noise Amplifier, Noise Figure, (if installed), dB	NFlna-del either Cell 728/731 in Line 37 WSForm	ENTER ##			
SS Ground Station RF Low Noise Amplifier, Gain, (if installed), dB	Glna	ENTER ##			
SS Ground Station Rx Circuit, Cmpnt/Cable Loss, after LNA and prior to Second Stage: CFG Y) to Xpndr/Receiver, dB	Lrr2 (always negative to 2nd)	ENTER ##			
Xpndr/Receiver, Noise Figure, dB	NFXpndr/Receiver	ENTER ##	0.9	0.9	0.9
SS Ground Station Overall System Loss from Ant Output to First Active Stage:CFG X) to LNA (if installed) or CFG Y) to Xpndr/Receiver, dB	Lrr (RF loss as negative)	WS FORMULA	-2.4	-2.4	-2.4
SS Ground Station System Loss Factor from Ant Output to First Active Stage	Lr=10^(-Lrr/10)	WS FORMULA	1.7	1.7	1.7
SS Ground Station Overall System Loss/Gain from Ant Output to Xpndr/Recei	Lrr3 (RF loss as negative)	WS FORMULA	-2.4	-2.4	-2.4
SS Ground Station Overall System Noise Figure, referred to Ant Output, (product of all cable losses + LNA NF/Gain, if installed, + Xpndr/Receiver NF), dB	NFsys=product of Lrr1+NF1na+Glna+Lrr2+NF2nd	WS FORMULA	3.3	3.3	3.3
Ground Station Overall System Noise Factor, referred to Ant Output,(incl X	Fsys=10^(NFsys/10)	WS FORMULA	2.2	2.2	2.2
SS Ground Station Noise Factor at First Active Stage, (LNA or Xpndr/Receiver)	F1na=10^(NF1na/10)Enter From Line 28 LNA or 3	WS FORMULA	1.2	1.2	1.2
SS Ground Station Antenna Temperature, Degrees K	Tant (dependent on elevation assumed)	ENTER ##	146.0	146.0	146.0
SS Ground Station System Noise Temperature, Degrees K	Ts=Tant/Lr+290*(Lr-1)/Lr+290*(F1na-1)	WS FORMULA	276.4	276.4	276.4
SS Ground Station System Noise Temperature, dBK	TsdB=10*logTs	WS FORMULA	24.4	24.4	24.4
SS Ground Station G/T at First Active Stage, (LNA or Xpndr/Receiver) Input,	G/T=Gr+Lrr-TsdB	WS FORMULA	11.8	11.8	11.8
Boltzmann's Constant, dB W/K/Hz	k=-228.6	GIVEN VALUE	-228.6	-228.6	-228.6
SS Ground Station Noise Spectral Density (No), dB W/Hz	No=-228.6+TsdB	WS FORMULA	-204.2	-204.2	-204.2
Total Power Rcvd.(Pr)/Noise Spectral Density,(No),at Xpndr/Receiver Input, dBHz	(Pant+Lrr)/No=Pant+Lrr-No	WS FORMULA	88.0	76.8	93.5
Residual Carrier Loss, dB	Lcar (always negative)	ENTER #	-0.2	-0.2	-0.2
Demodulation Noise Bandwidth/Data Bit Rate Range Modifier	Ldemod (always negative)	WS FORMULA	-3.0	-3.0	-3.0
Data Modulation Loss, dB (For Modulation Index,TH =1.18 radians)	Dl=10*log(2*J1(TH)^2) (see Bessel Tables)	ENTER #	-0.7	-0.7	-0.7
Data Bit Rate, bps	Rb	WS FORMULA	57600.0	57600.0	57600.0
Data Bit Rate, dBHz	RdB=10*logRb	WS FORMULA	47.5	47.6	47.5
SNR in Bit Rate Bandwidth, (Pr/No), dB	SNR=Pr/No-RdB+Dl+Ldemod+Lcar	WS FORMULA	36.5	25.2	42.0
Theoretical Eb/No for 1 in 10-6 Bit Error Rate	Eb/No	GIVEN VAR	10.7	10.7	10.7
Bit Synch Degradation, dB	Lbs (always negative)	GIVEN VAR	-1.0	-1.0	-1.0
Required Eb/No, dB	Eb/Norequired=Eb/No-Lbs	WS FORMULA	11.7	11.7	11.7
Required Pr/No, dBHz	Pr/Norequired=Eb/Norequired+RdB-Dl-Ldemod-Lcar	WS FORMULA	63.2	63.2	63.2
Telemetry Link Margin, dB	Margin=Pr/No-Pr/Norequired	WS FORMULA	24.8	13.6	30.2
Or if Telemetry Link Margin Value is x.x dB	(x.x)	ENTER ##	0.0	3.0	3.0
Then Resultant Maximum Range is ???.?? Km	???.??	WS FORMULA	12200.3	8708.2	23170.4

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TABLE 1.0 OSC GROUND STATION, WEST Va, TO SEASTAR SPACECRAFT S BAND COMMAND RF LINK
NADIR OR AFT BORESIGHT POINTING VIA COMMAND ANTENNA

PAGE: 1 REV:01	REVISION DATE:03-08-96	DOC:TB-SSCXDSN-48 GND STATION TO S/C CMD LINK.1			
Modulation: BPSK/PCM-L bps	19200	Demodulator Noise Bandwidth to Data Bit Rate Ratio, Lde			
OSC GROUND STATION TO SEASTAR SPACECRAFT (SS S/C) - COMMAND	S BAND RXS 1 OR 2 FROM ESCA & SSCA - CA3634	NADIR OR AFT POINTING	Std:Gor=41 dB Tant=150	Std:Gor=41 dB Tant=150	Std:Gor=41 d Tant=150
SEASTAR ANT POLARIZATION: LH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Resultant:	1.8518377	S/C OVERHEA	S/C AT HORIZ	S/C OVERHE
		ENTER For 0°	S/C Ant Gain at 0 Deg or Nadir	S/C Ant Gain	
OSC Ground Station to SS Spacecraft COMMAND LINK RANGE, km	D77-71	ENTER to	705.0	2575.0	705.
Ground Station Tx Power Output, 50 watt, dBW	Pt	GIVEN VAR	17.0	17.0	17
Ground Station Tx Circuit, Component/Cable Loss, dB	Lt (always negative)	GIVEN VAR	-9.5	-9.5	-9.
Ground Station Transmit Antenna Peak/Boresight Gain, dB	Gt	ENTER to / WS	41.0	41.0	41.
OSC Ground Station Tx EIRP, dBW	EIRP=Pt+Lt+Gt	WS FORMULA	48.6	48.6	48.
Ground Station Antenna 3 dB Beamwidth, Degrees	Bant	GIVEN VAR	1.5	1.5	1.
Ground Station Command Frequency, MHz	Fc	ENTER to	2092.6	2092.6	2092.
Range in km	R D77-71	WS FORMULA	705.0	2575.0	705.
Space Loss, dB	Ls=-92.44-20*log R-20*log Fc/1000)	WS FORMULA	-155.8	-167.1	-155.
Atmospheric Attenuation, dB		ENTER to	-0.5	-0.5	-0.
Rain Loss, dB	Crane or Lin Model	ENTER to	0.0	0.0	0.
Ground Station Pointing Error to SS S/C, Degrees	err	ENTER to	0.2	0.2	0.
Ground Station Pointing Loss, dB	Lpe=-12*(err/Bant)^2	WS FORMULA	-0.2	-0.2	-0.
SS S/C Rx Antennas Polarization/Axial Ratio Loss, dB	Lpa (always negative)	GIVEN VAR	-0.5	-0.5	-0.
S/C Rx Antennas Gain, dB	Gr	GIVEN VAR	2.5	2.5	-1.
SS S/C Rx Antennas 3 dB Beamwidth, Degrees	Bant	ENTER to	122.5	122.5	122.
SS S/C Rx Antennas Pointing Error, Degrees	err	ENTER to	5.0	5.0	5.
SS S/C Rx Antennas Pointing Loss, dB	Lpr=-12*(err/Bant)^2	WS FORMULA	0.0	0.0	0.
Total Received Power at SS S/C Antenna Output, (Prant), dBW	Prant=EIRP+Sl+Lpr+Lpa+Lpr+Gr	WS FORMULA	-106.0	-117.3	-110.
SS S/C Rx Circuit, Circuit/Cable Loss, from Ant Output to First Active Stage: CFG #1 to LNA (if installed), or CFG #1 to Xpondr/Receiver, dB	Lr1 (always negative to 1deg)	ENTER to	-5.1	-5.1	-5.
SS S/C RF Low Noise Amplifier, Noise Figure, (if installed), dB	RFNoise.dat either Cell P28/P31 in Rev 37 WKFormula	ENTER to			
SS S/C RF Low Noise Amplifier, Gain, (if installed), dB	Glna	ENTER to			
SS S/C Rx Circuit, Circuit/Cable Loss, after LNA and prior to Second Stage: CFG #1 to Xpondr/Receiver, dB	Lr2 (always negative to 2deg)	ENTER to			
Xpondr/Receiver, Noise Figure, dB	RFXpondr/Receiver	ENTER to	2.0	2.0	2.
SS S/C Overall System Loss from Ant Output to First Active Stage: CFG #1 to LNA (if installed) or CFG #1 to Xpondr/Receiver, dB	Lsr (RF loss is negative)	WS FORMULA	-5.1	-5.1	-5.
SS S/C System Loss Factor from Ant Output to First Active Stage	Lr=10^(-Lsr/10)	WS FORMULA	3.2	3.2	3.
SS S/C Overall System Loss/Gain from Ant Output to Xpondr/Receiver, dB	Ls3 (RF loss is negative)	WS FORMULA	-5.1	-5.1	-5.
SS S/C Overall System Noise Figure, referred to Ant Output, (product of all cable losses + LNA NF/Gain, if installed, + Xpondr/Receiver NF), dB	NFsys(grandtotal of Lr1+NF1+Glna+Lr2+NF2+Lr3)	WS FORMULA	7.1	7.1	7.
S/C Overall System Noise Factor, referred to Ant Output, incl Xpondr/Re	Fsys=10^(NFsys/10)	WS FORMULA	5.1	5.1	5.
SS S/C Noise Factor at First Active Stage, (LNA or Xpondr/Receiver)	F1=10^(NF1+Glna/10)Noise Figure from Item 28 LNA or 31 Xpondr	WS FORMULA	1.6	1.6	1.
SS S/C Antennas Temperature, Degrees K	Tant Measurement or elevation assumed	ENTER to	150.0	150.0	150.
SS S/C System Noise Temperature, Degrees K	Tsr=Tant/Lr+290*(Lr-1)/Lr+290*(F 1eq-1)	WS FORMULA	416.2	416.2	416.
SS S/C System Noise Temperature, dBK	Tsdb=10*log(Ts	WS FORMULA	26.2	26.2	26.
SS S/C G/T at First Active Stage, (LNA or Xpondr/Receiver) input, dB/K	G/T=Gr+Lsr-Tsdb	WS FORMULA	-28.3	-28.3	-32.
Boltzmann's Constant, dB W/K/Hz	k=-228.6	GIVEN VALUE	-228.6	-228.6	-228.
SS S/C Noise Spectral Density (Nst, dB W/Hz	Nst=-228.6+Tsdb	WS FORMULA	-202.4	-202.4	-202.
Total Power Based (Prt/Boltz Spectral Density (Nst=Lst Xpondr/Receiver Invert, dBHz	(Prant+Lrt1/Nst=Prant+Lsr-Nst	WS FORMULA	91.3	80.1	87.
Reduced Carrier Loss, dB	Lcar (always negative	ENTER to	-0.2	-0.2	-0.
Demodulator Noise Bandwidth/Data Bit Rate Ratio Modified	Lbnmod (always negative	WS FORMULA	0.0	0.0	0.
Data Modulation Loss, dB (For Modulation Index,PM =1.5 radians	Dl=(0*log(2*J1(PM)^2) from Bessel Tables	ENTER to	0.0	0.0	0.
Data Bit Rate, bps	Rb	WS FORMULA	19200.0	19200.0	19200.
Data Bit Rate, dBHz	Rdb=10*log(Rb	WS FORMULA	42.8	42.8	42.
SNR in Bit Rate Bandwidth, Pr/Ket, dB	SNR=Pr/Nst-Rdb+Dl+Lbnmod+Lcar	WS FORMULA	48.3	37.0	44.
Theoretical Eb/No for 1 in 10-6 Bit Error Rate	Eb/No	GIVEN VAR	10.7	10.7	10.
Bit Synch Degradation, dB	Lbs (always negative	GIVEN VAR	-1.0	-1.0	-1.
Required Eb/No, dB	Eb/No required=Eb/No-Lbs	WS FORMULA	11.7	11.7	11.
Required Pr/Ko, dBHz	Pr/No required=Eb/No required+Rdb-Dl-Lbnmod-Lcar	WS FORMULA	54.7	54.7	54.
Command Link Margin, dB	Margin=Pr/No-Pr/No required	WS FORMULA	26.6	25.3	29.
Or if Command Link Margin Value is set at dB	Dist	ENTER to	0.0	2.0	0.
Then Resultant Maximum Range where my Lin	D77-71	WS FORMULA	47543.3	52472.6	50010.

TABLE 9.0 SEASTAR SPACECRAFT TO COMMERCIAL GROUND STATION - L BAND DATA RF LINK 665.4 Kbps HRPT
NADIR BORESIGHT POINTING VIA S/C HIGH GAIN ANTENNA

PAGE:1 REV:01	REVISION DATE:02-08-96	DOC:TR-SSTLINK#-SS S/C TO GND STATION TLM LINK-km-RF
Modulation: PSK/TRL-2(Phase L bps	665000	Demodulator Noise Bandwidth to Data Bit Rate Ratio, Ldemo -
SEASTAR SPACECRAFT (SS S/C) TO X?M GROUND STATION - DATA	L BAND TXL 1 OR 2 TO ESLA HI GAIN CA3636	NADIR POINTING |Sta.Gain=?dB |Sta.Gain=?dB |Sta.Gain=?dB |ant=5.0 |ant=5.0 |ant=5.0 |Tant=150 |Tant=150 |Tant=150
SEASTAR ANT POLARIZATION: RH CIRCULAR	Km to NMI, divide coll 759 by coll entry C4 (Resu	1.8518377 S/C OVERHEA S/C AT HORIZ S/C OVERHEA:S
	ENTR? or ??	1.0 METER REFLECTOR 1.2 METER R
SS Spacecraft to Commercial Ground Station DATA LINK RANGE, km	D??.?? ENTER ??	705.0 2575.0 705.0
Spacecraft Tx Power Output, 5 watt, dBW	Pts GIVEN VAR	7.0 7.0 7.0
Spacecraft Tx Circuit, Component/Cable Loss, dB	Lts (always negative) GIVEN VAR	-1.7 -1.7 -1.7
Spacecraft Transmit Antenna Gain, dB	Gts ENTER ??/WSF	-2.5 3.0 -2.5
SS Spacecraft Tx EIRP, dBW	EIRP=Pts-Lts-Gts WS FORMULA	2.8 8.3 2.8
Spacecraft Antenna 3 dB Beamwidth, Degrees	Bant GIVEN VAR	240.0 240.0 240.0
Spacecraft Telemetry Frequency, MHz	Fc ENTER ??	1702.5 1702.5 1702.5
Range in km	R (???.?) WS FORMULA	705.0 2575.0 705.0
Space Loss, dB	Ls=-92.44-20*log(R)-20*log(Fc/1000) WS FORMULA	-154.0 -165.3 -154.0
Atmospheric Attenuation, dB	ENTER ??	-0.5 -0.5 -0.5
Rain Loss, dB	Crane or Lin Model ENTER ??	0.0 0.0 0.0
Spacecraft Pointing Error to Commercial Ground Station, Degrees	err ENTER ?	5.0 5.0 5.0
Spacecraft Pointing Loss, dB	Lpe=-12*(err/Bant)^2 WS FORMULA	0.0 0.0 0.0
Commercial Ground Station Rx Antenna Polarization/Axial Ratio Loss, dB	Lpo (always negative) GIVEN VAR	-0.5 -0.5 -0.5
Commercial Ground Station Rx Antenna Peak/Boresight Gain, dB	Gr GIVEN VAR	23.5 23.5 25.0
Commercial Ground Station Rx Antenna 3 dB Beamwidth, Degrees	Bear ENTER ?	12.0 12.0 10.0
Commercial Ground Station Rx Antenna Pointing Error, Degrees	err ENTER ?	0.4 0.4 0.4
Commercial Ground Station Rx Antenna Pointing Loss, dB	Lpr=-12*(err/Bear)^2 WS FORMULA	0.0 0.0 0.0
Total Received Power at Commercial Ground Station Antenna Output, (Prant), dBW	Prant=EIRP+Ls+Lpr+Lpo+Lpr+Gr WS FORMULA	-128.8 -134.5 -127.3
Commercial Ground Station Rx Circuit, Output/Cable Loss, from Ant Output to First Active Stage; CFG X) to LNA (if installed), or CFG Y) to Xpondr/Receiver, dB	Lcr1 (always negative to 1sig) ENTER ??	-0.1 -0.1 -0.1
Commercial Ground Station RF Low Noise Amplifier, Noise Figure, if installe	NFlna-(set either Coll ?28/?31 to Zero if? WSFormu ENTER ??	
Commercial Ground Station RF Low Noise Amplifier, Gain, (if installed), dB	Glna ENTER ??	
Commercial Ground Station Rx Circuit, Output/Cable Loss, after LNA and prior to Second Stage; CFG Y) to Xpndr/Receiver, dB	Lcr2 (always negative to 2sig) ENTER ??	
Xpndr/Receiver, Noise Figure, dB	NFXpndr/Receiver ENTER ??	0.7 0.7 0.7
Commercial Ground Station Overall System Loss from Ant Output to First Active Stage;CFG X) to LNA (if installed) or CFG Y) to Xpndr/Receiver, dB	Lsr (RF loss as negative) WS FORMULA	-0.1 -0.1 -0.1
Commercial Ground Station System Loss Factor from Ant Output to First Acti Lsr=10^(-Lsr/10) WS FORMULA		1.0 1.0 1.0
Commercial Ground Station Overall System Loss/Gain from Ant Output to X1 Lsr1 (RF loss as negative) WS FORMULA		-0.1 -0.1 -0.1
Commercial Ground Station Overall System Noise Figure, referred to Ant Output, (product of all cable losses + LNA NF/Gain, if installed, + ndr/Receiver NF), dB	NFsys(product of Lsr1+NF1 sig+Glna+Lsr2+NF2 sig) WS FORMULA	0.8 0.8 0.8
Commercial Ground Station Overall System Noise Factor, referred to Ant Out Fsys=10^(NFsys/10) WS FORMULA		1.2 1.2 1.2
Commercial Ground Station Noise Factor to First Active Stage, (LNA or Xpnd F1stage=10^(NF1 sig/10)Error From Zero 28 LNA or 3 WS FORMULA		1.2 1.2 1.2
Commercial Ground Station Antenna Temperature, Degrees K	Tant (determined on elevation pointed) ENTER ??	180.0 180.0 180.0
Commercial Ground Station System Noise Temperature, Degrees K	Ts=Tant/Lsr+290*(Lsr-1)/Lsr+290*F 1sig-1) WS FORMULA	200.0 200.0 200.0
Commercial Ground Station System Noise Temperature, dBK	Tant=10*log(Ts WS FORMULA	23.0 23.0 23.0
Commercial Ground Station G/T at First Active Stage, (LNA or Xpndr/Receiv G/T=Gr-Lsr-Tant WS FORMULA		0.4 0.4 1.9
Boltzmann's Constant, dB W/K/Hz	k=-228.6 GIVEN VALUE	-228.6 -228.6 -228.6
Commercial Ground Station Noise Spectral Density (No), dB W/Hz	No=-228.6+Tant WS FORMULA	-205.6 -205.6 -205.6
Total Power Recvd.(Pr)/Noise Spectral Density,(Eb=Last Xpndr/Receiver Input, dBHz	(Prant=Lsr1/No=Prant-Lsr-No WS FORMULA	78.7 71.0 78.2
Residual Carrier Loss, dB	Lrsc (always negative) ENTER ?	-0.2 -0.2 -0.2
Demodulator Noise Bandwidth/Data Bit Rate Range Modifier	Ldemod (always negative) WS FORMULA	-3.0 -3.0 -3.0
Data Modulation Loss, dB (For Modulation index,TH =1.12 radians)	Dl=10*log(2*J1(TH)^2) (see Bessel Tables) ENTER ?	-0.7 -0.7 -0.7
Data Bit Rate, bps	Rb WS FORMULA	665000.0 665000.0 665000.0
Data Bit Rate, dBHz	RdB=10*log(Rb WS FORMULA	58.2 58.2 58.2
SNR in Bit Rate Bandwidth, (Pr/Not, dB	SNR=Pr/No-2dB-Dl+Ldemod+Lsr WS FORMULA	14.6 5.9 16.1
Theoretical Eb/No for 1 in 10-5 Bit Error Rate	Eb/No GIVEN VAR	10.7 10.7 10.7
Bit Synch Degradation, dB	Lbs (always negative) GIVEN VAR	-1.0 -1.0 -1.0
Required Eb/No, dB	Eb/Nomeasured=Eb/No-Lbs WS FORMULA	11.7 11.7 11.7
Received Pr/No, dBHz	Pr/Nomeasured=Eb/Nomeasured+dBRb-Dl-Lsr WS FORMULA	73.3 73.3 73.3
Data Link Margin, dB	Margin=Pr/No-Pr/Nomeasured WS FORMULA	2.9 -2.8 4.4
Or if Data Link Margin Value is xx dB	ENTER ??	3.0 3.0 0.0
Then Resultant Maximum Range is ???.?? Km	D???.?? WS FORMULA	985.1 1214.3 1170.8

TABLE 9.0 SEASTAR SPACECRAFT TO COMMERCIAL GROUND STATION - L BAND DATA RF LINK 665.4 Kbps HRPT
NADIR BORESIGHT POINTING VIA S/C HIGH GAIN ANTENNA

Modulation: PSK/NRZ-S/Phase L type	665000.0		665000.0	
Demodulator Noise Bandwidth to Data Bit Rate Ratio, Linear	2.0		2.0	
SEASTAR SPACECRAFT (SS S/C) TO XPM GROUND STATION - DATA	Gor=LmS or=5.0 Tant=150		Gor=LmS or=5.0 Tant=150	
X	S/C OVERHEAD	S/C AT HORIZON	S/C OVERHEAD	S/C AT HORIZON
	1.5 METER REFLECTOR		2.0 METER REFLECTOR	
SS Spacecraft to OSC Ground Station DATA LINK RANGE, km	705.0	2575.0	705.0	2575.0
Spacecraft Tx Power Output, 5 watt, dBW	7.0	7.0	7.0	7.0
Spacecraft Tx Circuit, Component/Cable Loss, dB	-1.7	-1.7	-1.7	-1.7
Spacecraft Transmit Antenna Gain, dB	-2.5	3.0	-2.5	3.0
SS Spacecraft Tx EIRP, dBW	2.8	8.3	2.8	8.3
Spacecraft Antenna 3 dB Beamwidth, Degrees	240.0	240.0	240.0	240.0
Spacecraft Telemetry Frequency, MHz	1702.5	1702.5	1702.5	1702.5
Range in km	705.0	2575.0	705.0	2575.0
Space Loss, dB	-154.0	-165.3	-154.0	-165.3
Atmospheric Attenuation, dB	-0.5	-0.5	-0.5	-0.5
Rain Loss, dB	0.0	0.0	0.0	0.0
Spacecraft Pointing Error to Commercial Ground Station, Degrees	5.0	5.0	5.0	5.0
Spacecraft Pointing Loss, dB	0.0	0.0	0.0	0.0
Commercial Ground Station Rx Antenna Polarization/Axial Ratio Loss, dB	-0.5	-0.5	-0.5	-0.5
Commercial Ground Station Rx Antenna Peak/Boresight Gain, dB	26.8	26.8	29.6	29.6
Commercial Ground Station Rx Antenna 3 dB Beamwidth, Degrees	8.0	8.0	5.8	5.8
Commercial Ground Station Rx Antenna Pointing Error, Degrees	0.4	0.4	0.4	0.4
Commercial Ground Station Rx Antenna Pointing Loss, dB	0.0	0.0	-0.1	-0.1
Total Received Power at Commercial Ground Station Antenna Output, (Prant), dBW	-125.5	-131.2	-122.7	-128.5
Commercial Ground Station Rx Circuit, Cirpnt/Cable Loss, from Ant Output to First Active Stage; CFG X) to LNA (if installed), or CFG Y) to Xpondr/Receiver, dB	-0.1	-0.1	-0.1	-0.1
Commercial Ground Station RF Low Noise Amplifier, Noise Figure, if installed, dB				
Commercial Ground Station RF Low Noise Amplifier, Gain, if installed, dB				
Commercial Ground Station Rx Circuit, Cirpnt/Cable Loss, after LNA and prior to Second Stage; CFG Y) to Xpondr/Receiver, dB				
Xpondr/Receiver, Noise Figure, dB	0.7	0.7	0.7	0.7
Commercial Ground Station Overall System Loss from Ant Output to First Active Stage;CFG X) to LNA (if installed) or CFG Y) to Xpondr/Receiver, dB	-0.1	-0.1	-0.1	-0.1
Commercial Ground Station System Loss Factor from Ant Output to First Acti	1.0	1.0	1.0	1.0
Commercial Ground Station Overall System Loss/Gain from Ant Output to Xp	-0.1	-0.1	-0.1	-0.1
Commercial Ground Station Overall System Noise Figure, referred to Ant Output, (product of all cable losses + LNA NF/Gain, if installed, + Xpondr/Receiver NF), dB	0.8	0.8	0.8	0.8
Commercial Ground Station Overall System Noise Factor, referred to Ant Outp	1.2	1.2	1.2	1.2
Commercial Ground Station Noise Factor at First Active Stage, LNA or Xpondr	1.2	1.2	1.2	1.2
Commercial Ground Station Antenna Temperature, Degrees K	150.0	150.0	150.0	150.0
Commercial Ground Station System Noise Temperature, Degrees K	200.0	200.0	200.0	200.0
Commercial Ground Station System Noise Temperature, dBK	23.0	23.0	23.0	23.0
Commercial Ground Station G/T at First Active Stage, LNA or Xpondr/Receive	3.7	3.7	6.5	6.5
Boltzmann's Constant, dB W/K/Hz	-228.6	-228.6	-228.6	-228.6
Commercial Ground Station Noise Spectral Density (No), dB W/Hz	-205.6	-205.6	-205.6	-205.6
Total Power Recvd,(Pr)/Noise Spectral Density,(No),at Xpondr/Receiver Input, dBHz	80.0	74.3	82.8	77.2
Residual Carrier Loss, dB	-0.2	-0.2	-0.2	-0.2
Demodulator Noise Bandwidth/Data Bit Rate Range Identifier	-3.0	-3.0	-3.0	-3.0
Data Modulation Loss, dB (For Modulation Index,PM = 1.15 radians)	-0.7	-0.7	-0.7	-0.7
Data Bit Rate, bps	665000.0	665000.0	665000.0	665000.0
Data Bit Rate, dBHz	58.2	58.2	58.2	58.2
SNR in Bit Rate Bandwidth, (Pr/No), dB	17.3	12.1	20.7	14.9
Theoretical Eb/No for 1 in 10-6 Bit Error Rate	10.7	10.7	10.7	10.7
Bit Synch Degradation, dB	-1.0	-1.0	-1.0	-1.0
Required Eb/No, dB	11.7	11.7	11.7	11.7
Recovered Pr/No, dBHz	73.3	73.3	73.3	73.3
Data Link Margin, dB	6.2	0.4	9.0	3.2
Or if Data Link Margin Value is set dB	0.0	3.0	0.0	3.0
Then Resultant Maximum Range is 777.77 Km	1428.6	1313.4	1979.6	2879.5

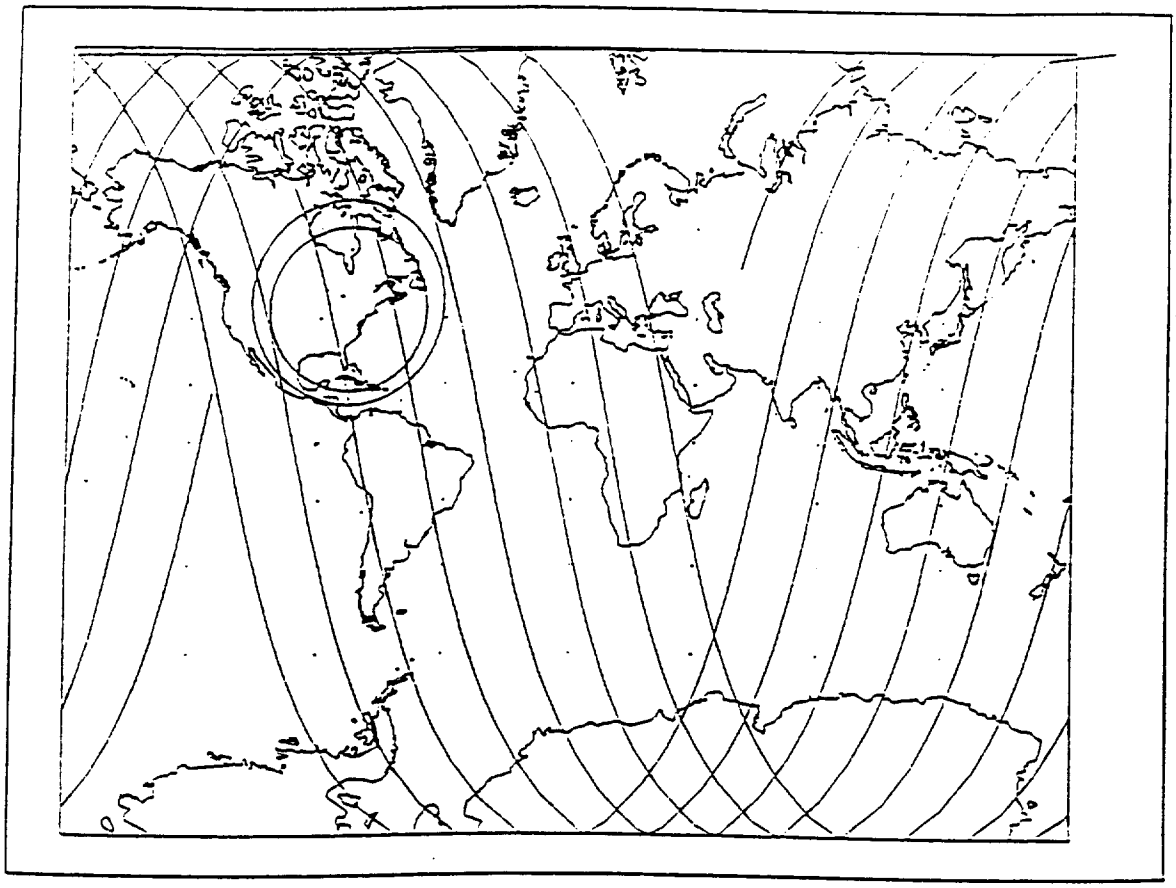
SeaStar SPACE STATION OPERATIONAL ORBITAL PARAMETERS

AREA OF OPERATION: NonGeostationary Circular Polar Orbit

PARAMETER	MEASUREMENT
Apogee	705 kilometers / 380.67 nautical miles
Perigee	705 kilometers / 380.67 nautical miles
Radius	7083.14 kilometers / 3824.59 nmi
Eccentricity	≤ 0.001
Equator Crossing	Noon Local ± 15 minutes
Node	Descending
Velocity	7.50164 kilometer/second
Period	5932.66 seconds / 98.88 minutes
Orbit Inclination	98.233 degrees

TYPICAL SeaStar SPACECRAFT GROUND TRACK

Mercator Projection
705 km circular spacecraft orbit
[Showing OSC Remote Tracking Station]



SeaStar EARTH STATION PHYSICAL PARAMETERS

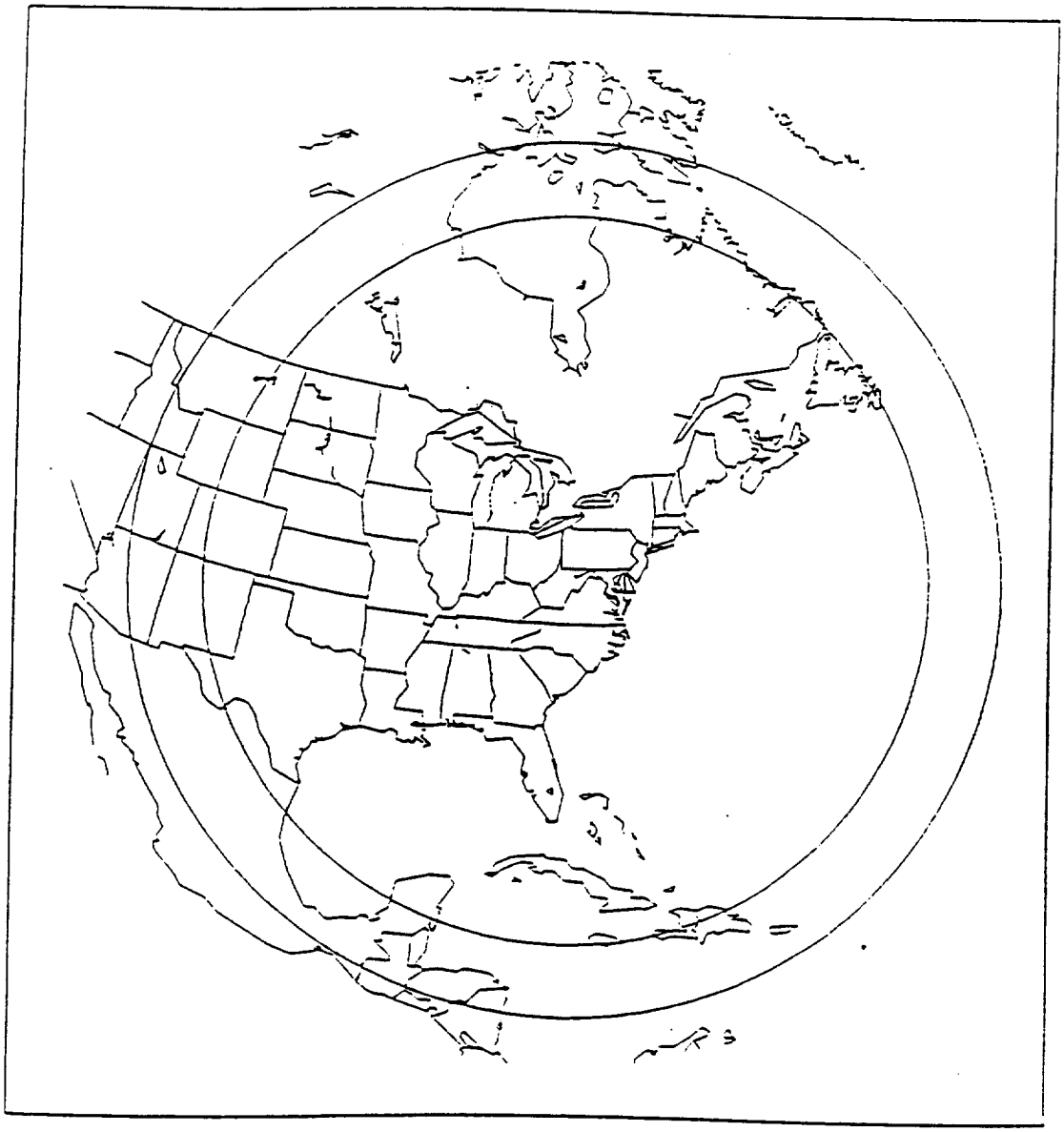
Location: OSC Remote Tracking Station, 1 SeaStar Point, Fairmont, Marion County, West Virginia
Function: *Serve as SeaStar Spacecraft Telemetry, Tracking, and Commanding (TT&C) earth station (fixed site)*
Operations Note: *The OSC RTS went operational in April 1995 supporting TT&C and Mission Data Recovery of the NASA MicroLab-1 (ML-1) spacecraft. Both ML-1 and SeaStar use the same earth-to-space uplink parameters and equipment. The NTIA licensed the ML-1 satellite system under file number SPS-9685/2.*

AREA OF OPERATION: Fixed Location

Latitude	39 degrees 26m 00s N
Longitude	080 degrees 12m 00s W

TT&C EARTH STATION VISIBILITY CIRCLES

Orthographic Projection
705 km circular spacecraft orbit



Outer Circle = 0 degree horizon elevation
Inner Circle = 5 degree horizon elevation

TEMPORAL PARAMETERS

30 Day Orbit Cycle Analysis
TT&C Visibility

Maximum TT&C Transmission Duty Cycle
[Space and Earth Station]
[0 Degree Elevation = Worst Case]

	0 Degree El	5 Degree El
Avg. Pass Duration	11.2257 min	9.1144 min
Avg. Number of Passes	5.6666 / day	4.700 / day
Total Xmt Time Available	63.6115 min/day	42.8377 min/day
% of Day	4.42 %	2.970 %

RF MODES OF OPERATION

MODE	LINK	AREA of COVERAGE
TT&C	S-Band ⇑ / L-Band ⇓	Station Circle of RTS
Mission Data Recovery (Direct Downlink Data)	L-Band ⇓	Global*

* = The SeaStar L-Band transmitter operates in broadcast mode continuously during the daylight portions of the spacecraft's orbit downlinking Local Area Coverage (LAC) HRPT data to research and commercial HRPT stations located around the globe.