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/NRZ-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:Gcs=?dB err=5.0 Tant=146	Std:Gcs=?dB err=5.0 Tant=146	Std:Gcs=?dB err=5.0 Tant=146
SEASTAR ANT POLARISATION: RH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Result	1.55183777	S/C OVERHEA	S/C AT HORIZ	S/C OVERHEA
		ENTR'For ##	S/C Ant Gain @ 0 Deg or Nadir		S/C Ant Gain @ 6.
SS Spacecraft to OSC Ground Station DATA LINK RANGE, km	D77.71	ENTER ##	705.0	2575.0	705.0
Spacecraft Tx Power Output, 5 watt, dBW	Pst	GIVEN VAR	7.0	7.0	7.0
Spacecraft Tx Circuit, Component/Cable Loss, dB	Lcs (always negative)	GIVEN VAR	-1.7	-1.7	-1.7
Spacecraft Transmit Antenna Gain, dB	Gst	ENTER ##/WSF	-2.5	-2.5	3.0
SS Spacecraft Tx EIRP, dBW	EIRP=Pst-Lcs-Gst	WS FORMULA	2.8	2.8	8.3
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 D77.71	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/Bant)^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	Banr	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/Banr)^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)	ENTER ##	-2.4	-2.4	-2.4
SS Ground Station RF Low Noise Amplifier, Noise Figure, (if installed), dB	NF1na-del either Cell 728/731 in Row 37 WSFormul	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)	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	Ls=10^(-Lsr/10)	WS FORMULA	1.7	1.7	1.7
SS Ground Station Overall System Loss/Gain from Ant Output to Xpndr/Rec	Lsr3 (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+NF1lna+Glna+Lcr2+NF2rcvr	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
Ground Station Noise Factor at First Active Stage, (LNA or Xpndr/Receiver)	F1lna=10^(NF1lna/10)Enter From Row 25 LNA or 31	WS FORMULA	1.2	1.2	1.2
SS Ground Station Antenna Temperature, Degrees K	Tant (dependent on elevation pointed)	ENTER ##	146.0	146.0	146.0
SS Ground Station System Noise Temperature, Degrees K	Ts=Tant/Ls+290*(Ls-1)/Ls+290*(F1lna-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(J1^2(TH)^2) from 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/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/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	73.3	73.3	73.3
Data Link Margin, dB	Margin=Pr/No-Pr/Norequired	WS FORMULA	14.7	3.5	19.7
If Data Link Margin Value is x.x dB	(x.x)	ENTER ##	0.0	0.0	0.0
Then Resultant Maximum Range is 777.77 Km	D77.71	WS FORMULA	3522.2	2564.4	6822.1

TABLE 2.0 SEASTAR SPACECRAFT TO OSC GROUND STATION, WEST Va, - L BAND TELEMETRY RF LINK HDLC
NADIR ZOREIGHT POINTING VIA S/C HIGH GAIN ANTENNA

PAGE:1 REV-01	REVERSE DATE:02-08-96	DOC:SB-SETLMEX-HR S/C TO GND STATION TLM LINK-Xm		
Modulation: PSK/NRZ-S(Phase L, bps	57600	Demodulator Noise Bandwidth to Data Bit Rate Ratio, Ldo		
SEASTAR SPACECRAFT (SS S/C) TO OSC GROUND STATION - TELEMETRY	L BAND TXL 1 OR 2 TO ESLA (HI GAIN) CA3636	NADIR POINTING	Std:Gain=7dB Ant=5.0 Tant=146	Std:Gain=7dB Ant=5.0 Tant=146	Std:Gain=7dB Ant=5.0 Tant=146
SEASTAR ANT POLARISATION: RH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Resu	1.85318377	S/C OVERHEA	S/C AT HORIZ	S/C OVERHE
		ENTER'S or 99	S/C Ant Gain = 0 Deg or Nadir	9	S/C Ant Gain =
SS Spacecraft to OSC Ground Station TELEMETRY LINK RANGE, km	[yyy.y]	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	Lsx (always negative	GIVEN VAR	-1.7	-1.7	-1.
Spacecraft Transmit Antenna Gain, dB	Gsx	ENTER ##/WS	-2.5	-2.5	3.
SS Spacecraft Tx EIRP, dBW	EIRP=Ptx+Lsx+Gsx	WS FORMULA	2.8	2.8	8.
Spacecraft Antenna 3 dB Beamwidth, Degrees	Bsat	GIVEN VAR	240.0	240.0	240.
Spacecraft Telemetry Frequency, MHz	Fc	ENTER ##	1702.5	1702.5	1702.
Range in km	R [yyy.y]	WS FORMULA	705.0	2575.0	705.
Space Loss, dB	Ls=-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	Cruise or Lift Model	ENTER ##	0.0	0.0	0.
Spacecraft Pointing Error to SS Ground Station, Degrees	ept	ENTER #	5.0	5.0	5.
Spacecraft Pointing Loss, dB	Lpx=-12*(ept/Bsat)^2	WS FORMULA	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.
SS Ground Station Rx Antenna Peak/Boresight Gain, dB	Gr	GIVEN VAR	38.6	38.6	38.
SS Ground Station Rx Antenna 3 dB Beamwidth, Degrees	Brec	ENTER #	1.9	1.9	1.
SS Ground Station Rx Antenna Pointing Error, Degrees	erc	ENTER #	0.2	0.2	0.
SS Ground Station Rx Antenna Pointing Loss, dB	Lpr=-12*(erc/Brec)^2	WS FORMULA	-0.1	-0.1	-0.
Total Received Power at SS Ground Station Antenna Output, (Prant), dBW	Prant=EIRP+Ss+Lpr+Lpa+Lpx+Gr	WS FORMULA	-113.8	-125.0	-108.
SS Ground Station Rx Circuit, Carpet/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 or Zero)	ENTER ##	-2.4	-2.4	-2.
SS Ground Station RF Low Noise Amplifier, Noise Figure, (if installed), dB	NFlna=4el neither Cell P28/P31 to Zero 37 WSFormu	ENTER ##			
SS Ground Station RF Low Noise Amplifier, Gain, (if installed), dB	Glna	ENTER ##			
SS Ground Station Rx Circuit, Carpet/Cable Loss, after LNA and prior to Second Stage: CFG Y) to Xpndr/Receiver, dB	Lrr2 (always negative or Zero)	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/Receiv	Lrr3 (RF loss as negative)	WS FORMULA	-2.4	-2.4	-2.4
SS Ground Station Overall System Noise Figure, referred to Ant Output, (presence of all cable losses + LNA NF/Gain, if installed, + Xpndr/Receiver NF) dB	NFsys=preceding of Lrr1+NF1+Glna+Lrr2+NF2+Lrr3	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)	F1stage=10^(NF1stag/10)Either From Zero 28 LNA or 3	WS FORMULA	1.2	1.2	1.2
SS Ground Station Antenna Temperature, Degrees K	Tant (dependence 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*(F 1-stg-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+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 Recd.(Pr)/Noise Spectral Density,(Eb/No) at Xpndr/Receiver Input, dBHz	(Prant+Lrr1/Nor+Prec+Lrr+No	WS FORMULA	88.0	76.8	93.5
Residual Carrier Loss, dB	Lcar (always negative)	ENTER #	-3.2	-3.2	-3.2
Demodulation Noise Bandwidth/Data Bit Rate Range Modifier	Lmod (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 General 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	RbDb=10*log(Rb	WS FORMULA	47.6	47.6	47.6
SNR in Bit Rate Bandwidth, (Pr/No), dB	SNR=Pr/No-RbDb-Dl-Lcarrier-Lmod	WS FORMULA	26.5	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
Received Eb/No, dB	Eb/No=SNR+Rb-Nor-Lbs	WS FORMULA	11.7	11.7	11.7
Received Pr/No, dBHz	Pr/No=Prec+Gr/Nor-RbDb-Dl-Lcarrier-Lmod	WS FORMULA	63.2	63.2	63.2
Telemetry Link Margin, dB	Margin=Pr/No-Pr/No required	WS FORMULA	24.3	13.6	30.3
Ov if Telemetry Link Margin Value is x.x dB	[x.x]	ENTER ##	0.0	2.0	0.0
Then Resultant Maximum Range is yyy.yy Km	[yyy.y]	WS FORMULA	12200.3	8708.2	23170.4

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:02-08-96	DOC:[illegible] GND STATION TO S/C CMD LINK:			
Modulation: [illegible] bps	19200	Demodulator Noise Bandwidth to Data Bit Rate Ratio, Ldm			
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:Gr=-1 dB ert=0.2 Tant=150	Std:Gr=-1 dB ert=0.2 Tant=150	Std:Gr=-1 d ert=0.2 Tant=150
SEASTAR ANT POLARISATION: LH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Resultant:	1.8518377	S/C OVERHEA	S/C AT HORIZ	S/C OVERH
		ENTR For 90°	S/C Ant Gain 0 Deg or Nadir	8/	S/C Ant Gain
OSC Ground Station to SS Spacecraft COMMAND LINK RANGE, km	D77-71	ENTER ##	705.0	2575.0	705
Ground Station Tx Power Output, 50 watt, dBW	Ptx	GIVEN VAR	17.0	17.0	17
Ground Station Tx Circuit, Component/Cable Loss, dB	Ltx (always negative)	GIVEN VAR	-9.5	-9.5	-9.
Ground Station Transmit Antenna Peak/Boresight Gain, dB	Gtx	ENTER ##/WS	41.0	41.0	41.
OSC Ground Station Tx EIRP, dBW	EIRP=Ptx-Ltx-Gtx	WS FORMULA	48.6	48.6	48
Ground Station Antenna 3 dB Beamwidth, Degrees	Btxt	GIVEN VAR	1.5	1.5	1.
Ground Station Command Frequency, MHz	Fc	ENTER ##	2092.6	2092.6	2092.
Range in km	R D77-71	WS FORMULA	705.0	2575.0	705.
Space Loss, dB	Sl=-92.44-20*log(R)-20*log(Fc/1000)	WS FORMULA	-155.8	-167.1	-155.
Atmospheric Attenuation, dB		ENTER ##	-0.5	-0.5	-0.
Rain Loss, dB	Crane or Lin Model	ENTER ##	0.0	0.0	0.
Ground Station Pointing Error to SS S/C, Degrees	ert	ENTER #	0.2	0.2	0.
Ground Station Pointing Loss, dB	Lpt=-12*(ert/Btxt)^2	WS FORMULA	-0.2	-0.2	-0.
SS S/C Rx Antenna Polarization/Axial Ratio Loss, dB	Lpo (always negative)	GIVEN VAR	-0.5	-0.5	-0.
S/C Rx Antenna Gain, dB	Gr	GIVEN VAR	2.5	2.5	-1.
SS S/C Rx Antenna 3 dB Beamwidth, Degrees	Bsr	ENTER #	122.5	122.5	122.
SS S/C Rx Antenna Pointing Error, Degrees	err	ENTER #	5.0	5.0	5.
SS S/C Rx Antenna Pointing Loss, dB	Lpr=-12*(err/Bsr)^2	WS FORMULA	0.0	0.0	0.
Total Received Power at SS S/C Antenna Output, (Pant), dBW	Pant=EIRP+Sl+Lpt+Lpo+Lpr+Gr	WS FORMULA	-106.0	-117.3	-110.
SS S/C 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 1st)	ENTER ##	-5.1	-5.1	-5.
SS S/C RF Low Noise Amplifier, Noise Figure, (if installed), dB	NF[illegible] either Cell [illegible] in Row 37 WS Formula	ENTER ##			
SS S/C RF Low Noise Amplifier, Gain, (if installed), dB	Glna	ENTER ##			
SS S/C 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 ##	2.0	2.0	2.
SS S/C 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 is negative)	WS FORMULA	-5.1	-5.1	-5.
SS S/C System Loss Factor from Ant Output to First Active Stage	Lr=10^(-Lrr/10)	WS FORMULA	3.2	3.2	3.
SS S/C Overall System Loss/Gain from Ant Output to Xpndr/Receiver, dB	Lrr3 (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, + Xpndr/Receiver NF), dB	NFsys(product of Lrr1+NF1[illegible]+Glna+Lrr2+NF2[illegible])	WS FORMULA	7.1	7.1	7.
S/C Overall System Noise Factor, referred to Ant Output,(incl Xpndr/Rx	Fsys=10^(NFsys/10)	WS FORMULA	5.1	5.1	5.
SS S/C Noise Factor at First Active Stage, (LNA or Xpndr/Receiver)	F1[illegible]=10^(NF1[illegible]/10)[illegible] from Row 28 LNA or 32 Xpndr	WS FORMULA	1.6	1.6	1.
SS S/C Antenna Temperature, Degrees K	Tant (dependent on [illegible])	ENTER ##	150.0	150.0	150.
SS S/C System Noise Temperature, Degrees K	Ts=Tant/Lr+290*(Lr-1)/Lr+290*(F1[illegible]-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 Xpndr/Receiver) input, dB/K	G/T=Gr+Lrr-TsdB	WS FORMULA	-28.8	-28.8	-32.
Boltzmann's Constant, dB W/K/Hz	k=-228.6	GIVEN VALUE	-228.6	-228.6	-228.
SS S/C Noise Spectral Density (No), dB W/Hz	No=-228.6+TsdB	WS FORMULA	-202.4	-202.4	-202.
Total Power Recvd,(Pr)/Noise Spectral Density,(No),at Xpndr/Receiver Input, dBHz	(Pant+Lrr)/No=Pant+Lrr-No	WS FORMULA	91.2	80.1	87.
Residual Carrier Loss, dB	Lcar (always negative)	ENTER #	-0.2	-0.2	-0.
Demodulation Noise Bandwidth/Data Bit Rate Range Modifier	Ldemod (always negative)	WS FORMULA	0.0	0.0	0.
Data Modulation Loss, dB (For Modulation Index,TH =1.5 radians)	Dl=10*log(2*J1(TH)^2) [illegible] Tables	ENTER #	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	42.3	42.3	42.
SNR in Bit Rate Bandwidth, (Pr/No), dB	SNR=Pr/No-RdB+Dl+Ldemod+Lcar	WS FORMULA	48.2	37.3	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/No, dBHz	Pr/No required=Eb/No required+RdB-Dl-Ldemod-Lcar	WS FORMULA	54.7	54.7	54.
Command Link Margin, dB	Margin=Pr/No-Pr/No required	WS FORMULA	36.6	25.3	32.
Cmd Command Link Margin Value in dB	[illegible]	ENTER ##	0.0	25.3	0.
Then Resultant Maximum Range in D77-71 Km	D77-71	WS FORMULA	47562.3	22672.6	30010.

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:02-08-94	DOC:WS-SSTLMXX-SS S/C TO GND STATION TLM LINK-km-RF			
Modulation: PSK/NRZ-BiPhase 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:Gcr=?dB err=5.0 Tant=150	Sta:Gcr=?dB err=5.0 Tant=150	Sta:Gcr=?dB err=5.0 Tant=150
SEASTAR ANT POLARIZATION: RH CIRCULAR	Km to NMI, divide cell 759 by cell entry C4 (Resu	1.8518377	S/C OVERHEA	S/C AT HORIZ	S/C OVERHEA
		ENTRY or 90°	1.0 METER REFLECTOR		1.2 METER R
SS Spacecraft to Commercial Ground Station DATA LINK RANGE, km	(777.7)	ENTER ##	705.0	2575.0	705.0
Spacecraft Tx Power Output, 5 watt, dBW	Ptx	GIVEN VAR	7.0	7.0	7.0
Spacecraft Tx Circuit, Component/Cable Loss, dB	Ltx (always negative)	GIVEN VAR	-1.7	-1.7	-1.7
Spacecraft Transmit Antenna Gain, dB	Gtx	ENTER ##/WSF	-2.5	3.0	-2.5
SS Spacecraft Tx EIRP, dBW	EIRP=Ptx-Ltx-Gtx	WS FORMULA	2.8	8.3	2.8
Spacecraft Antenna 3 dB Beamwidth, Degrees	Bsat	GIVEN VAR	240.0	240.0	240.0
Spacecraft Telemetry Frequency, MHz	Fc	ENTER ##	1702.5	1702.5	1702.5
Range in km	R (777.7)	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 Commercial Ground Station, Degrees	ert	ENTER #	5.0	5.0	5.0
Spacecraft Pointing Loss, dB	Lpt=-12*(ert/Bsat)^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	Bgsr	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/Bgsr)^2	WS FORMULA	0.0	0.0	0.0
Total Received Power at Commercial Ground Station Antenna Output, (Pant), dBW	Pant=EIRP+Sl+Lpt+Lpo+Lpr+Gr	WS FORMULA	-128.8	-134.5	-127.3
Commercial 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 1stg)	ENTER ##	-0.1	-0.1	-0.1
Commercial Ground Station RF Low Noise Amplifier, Noise Figure, (if installe	NFlna-del either Cell 728/731 in Row 37 WSForm	ENTER ##			
Commercial Ground Station RF Low Noise Amplifier, Gain, (if installed), dB	Glna	ENTER ##			
Commercial Ground Station Rx Circuit, Cmpnt/Cable Loss, after LNA and prior to Second Stage: CFG Y) to Xpndr/Receiver, dB	Lcr2 (always negative to 2stg)	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	Lcr (RF loss as negative)	WS FORMULA	-0.1	-0.1	-0.1
Commercial Ground Station System Loss Factor from Ant Output to First Act	Lc=10^(-Lcr/10)	WS FORMULA	1.0	1.0	1.0
Commercial Ground Station Overall System Loss/Gain from Ant Output to X	Lcr3 (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, + Xpndr/Receiver NF), dB	NFsys=product of Lcr1+NF1stg-Glna-Lcr2+NF2stg	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 at First Active Stage, (LNA or Xpnd	F1stg=10^(NF1stg/10)Enter From Row 28 LNA or X	WS FORMULA	1.2	1.2	1.2
Commercial Ground Station Antenna Temperature, Degrees K	Tant (dependent on elevation position)	ENTER ##	180.0	180.0	180.0
Commercial Ground Station System Noise Temperature, Degrees K	Ts=Tant/Lc+290*(Lc-1)/Lc+290*(F1stg-1)	WS FORMULA	200.0	200.0	200.0
Commercial Ground Station System Noise Temperature, dBK	TsdB=10*logTs	WS FORMULA	23.0	23.0	23.0
Commercial Ground Station G/T at First Active Stage, (LNA or Xpndr/Receiver	G/T=Gr+Lcr-TsdB	WS FORMULA	0.4	0.4	1.9
Boltzman 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+TsdB	WS FORMULA	-205.6	-205.6	-205.6
Total Power Rcvd.(Pr)/Noise Spectral Density,(No),at Xpndr/Receiver Input, dBHz	(Pant+Lcr)/No=Pant+Lcr-No	WS FORMULA	78.7	71.0	78.2
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)	Cl=10*log(2*J1(TH)^2) (use 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*logRb	WS FORMULA	58.2	58.2	58.2
SNR in Bit Rate Bandwidth, (Pr/No), dB	SNR=Pr/No-RdB+Cl+Ldemod+Lcar	WS FORMULA	14.6	5.9	16.1
Theoretical Eb/No for 1 in 10-n 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(reqd)+RdB-Cl-Ldemod-Lcar	WS FORMULA	73.3	73.3	73.3
Data Link Margin, dB	Margin=Pr/No-Pr/No(required)	WS FORMULA	2.9	-2.3	4.4
Or if Data Link Margin Value is x.x dB	(x.x)	ENTER ##	3.0	2.0	0.0
Then Resultant Maximum Range is 777.77 Km	(777.7)	WS FORMULA	982.1	1214.3	1179.8

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, Likewise	2.0		2.0	
SEASTAR SPACECRAFT (SS S/C) TO X?M GROUND STATION - DATA	Gor=Lm8 or=5.0 Tant=150		Gor=Lm8 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, Cmpnt/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, Cmpnt/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 Act	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 NFL, 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/Receiver	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 (Not, dB W/Hz	-205.6	-205.6	-205.6	-205.6
Total Power Recd.(Pr)/Noise Spectral Density,(Ro),at Xpondr/Receiver Input, dBHz	80.9	74.2	82.9	77.2
Residual Carrier Loss, dB	-0.2	-0.2	-0.2	-0.2
Demodulator Noise Bandwidth/Data Bit Rate Ratio Matched	-3.0	-3.0	-3.0	-3.0
Data Modulation Loss, dB (For Modulation Index,TH =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	17.9	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
Received Pr/No, dBHz	73.3	73.3	73.3	73.3
Data Link Margin, dB	4.2	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	1913.4	1979.6	2639.5

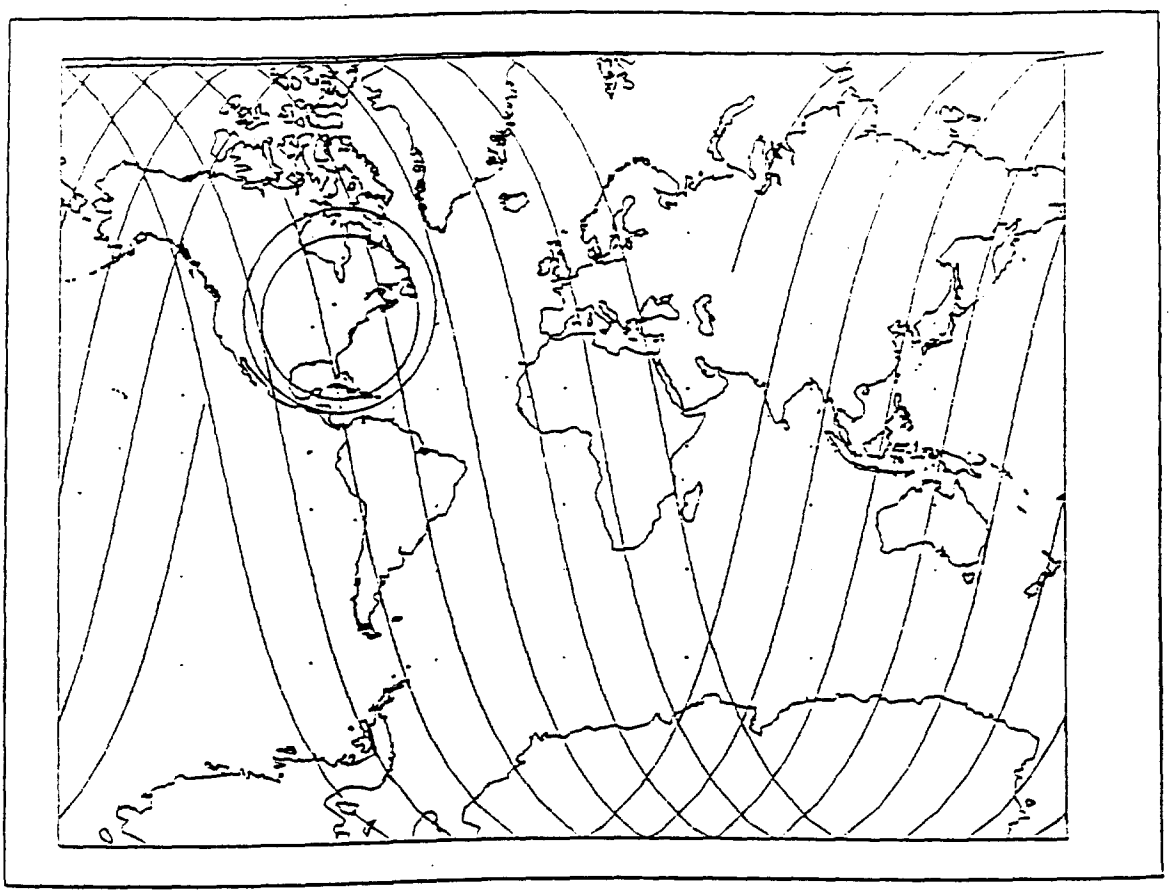
SeaStar SPACE STATION OPERATIONAL ORBITAL PARAMETERS

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

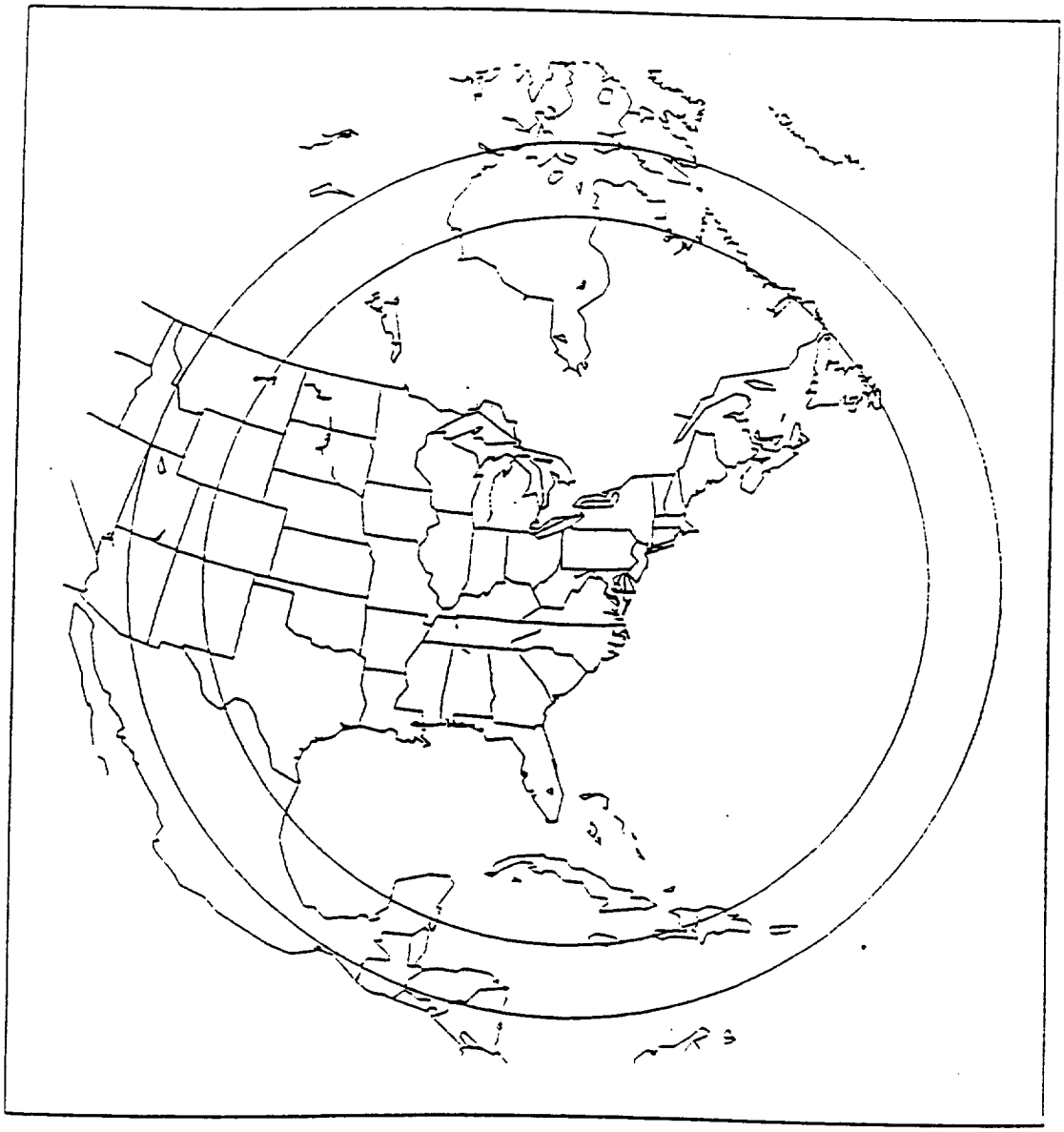
Location: OSC Remote Tracking Station, 1 SeaStar Point, Fairmont, Marion County, West Virginia
Function: *Serve as SeaStar Spacecraft Telemetry, Tracking, and Commanding (TT&C) earth station (fixed site)*
Operations Note: *The OSC RTS went operational in April 1995 supporting TT&C and Mission Data Recovery 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.