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SYSTEM FAILURE OPERATIONAL RECOVERY

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VLBI is a very complex science which requires operators to simultaneously run multiple complex systems to acquire and record high quality data. This data then can be transferred or shipped to the multiple correlators around the world. They will then produce a product that the scientists can analyze. As an operator, you must be attentive and responsive to all of the systems at your VLBI antenna site. One simple oversight can cause a significant data loss which could greatly degrade the quality of our science product.

As operators we are first in line building the chain of excellence.

Since the inception of the first NASA TOW meeting in 1994 our science, engineering, technician, and operators working as a single worldwide team, have contributed to improve this technology not only in capability but also reliability to accomplish VLBI science.

A	B	C	D	E	F	G
Total Session Year, Days	**2018**	**1455 Days**	**2021**	**1973 Days**	**2022**	**2147 Days**
Total Loss	**13.80%**	**203 Days**	**11.54%**	**227.6 Days**	**10.72%**	**230.02 Days**
Failure Location	**Percentage**	**Days**	**Percentage**	**Days**	**Percentage**	**Days**
Antenna	4.3	63	4.390	86.6	2.85	61.2
Receiver	2.8	41	2.090	41.2	0.98	21
RFI	2	29	1.880	37.1	2.76	59.25
Misc	3	44	1.660	32.7	1.76	37.8
Recorder	0.4	6	0.390	7.5	0.32	6.8
Clock			0.380	7.5	0.21	4.5
Rack (Backend VC's/RDBE/ UDC/ D	0.9	13	0.320	6.3	1.33	28.5
Power	0.2	3	0.220	4.3	0.26	5.6
Operator			0.170	3.2	0.08	1.72
Software			0.020	0.4	0.15	3.22
Unknown			0.020	0.4	0.02	0.43
shipping	0.2	4				

What we cannot guarantee is that these complex systems run without failure. Everything from the large antenna to the smallest connection is confirmed operational by using the time tested and continually updated prechecks listing at each of your stations. Once they are completed you know as of that time your system is fully operational.

One second after the session starts any subsystem could fail and the operator must be in a position to notice, identify, notify, and possibly repair any possible failure at your station.

5575 Days of data for 2018, 2021, and 2022

Antenna: **210.8 days** -Any problem with the antenna system from motion to mechanical failure. Without this you cannot accomplish VLBI

Receiver: 103.2 days – The receiver is complex and has many supporting subsystems which when operating correctly enables it to be highly sensitive. The are failure cases which when addressed correctly allows some receiver to run slightly compromised but still provides good signal levels and data.

RFI: 125.3 days – This failure most operators have no control over. These are signals local to our antenna systems which can electronically cause reduction in sensitivity. Once identified locally this information should be passed onto the correlators and science staff to see if the can remediate the problem.

Miscellaneous: 114.5 days – Schedule conflicts or weather limitations

Recorder: 20.3 days- Failures of Mark5, Mark6, and other systems.

Rack: 44.8 days- Failures with UDC, RDBE, DBBC, RF Distributer, and other systems

Clock: 12 days- Maser, GPS, system time

Power: 12.9 days – Antenna site and or operational power to the equipment

Operator: 5 days – Mistakes caused by humans

Software: 3.62 days- Scheduling errors? Security Updates?

Unknown: .83 days - ????????

Power Failure Recovery: To recover from a full power outage you should understand that each site will have a specific procedure and response. As an operator you first reaction may be making sure you are safe and notify the appropriate personnel. Once the power has been restored as an operator you may be responsible to bring all of the system back into operational condition. This means you must start at the beginning of your precheck procedure to make sure every system is fully functional. This step takes more time but insures you are not trying to operate in with a failed system. Nothing is worse that rushing a restart and finding out from the correlator that you had not data on your disks after the power outage.

Antenna Failure: Each antenna and its control systems are different and specific to your station. You may already have procedure installed for you as an operator to call other support personnel in case of a problem. The key is recognizing a problem within a short period of time. Once problem is resolved you must confirm antenna operation and pointing.

Timing problem: Diagnosing what is the real problem is somewhat complex being multiple signals 5 MHz, 10 Mhz, and 1 PPS may be generated by masers, GPS or multiple timing systems. You must attempt to identify which timing signal has failed by crosschecking all timing signals.

Maser: Recovering from a maser failure quickly is a most unlikely scenario unless you have a backup system. If it is the maser and you have an operational backup, you should switch onto the operational system but you would be required to setup all of your devices to make sure they are locked and using the new maser signals. If you have no backup maser, checking the power, and certain levels within the maser that may be displayed is a good start.

GPS Clocks: If you suspect a GPS failure you must make sure by checking if the display is showing multiple satellites that are being tracked. You can also confirm that the 1 PPS output signal is of normal level and correct.

Computer Time: Most all of our subsystems have computers within them for operational control. Each of those usually have a network connection which syncs to a remote time server This keeps that computer aligned to an accurate clock. If we lose network connection, maser or GPS signal, or power each system may take some time to sync back up which may cause operational issues.

DAT Rack or Backend systems: Depending on what system you use which takes the receiver system signals and translates it into data bits there are multiple failures and recoveries

RDBE, R2DBE, Video Converters, Decoders, counters, Baseband converters, Rf Distributers, DBBC's, Formatters are all complex devices and procedures must be on hand at each site to enable failure detection and recovery. Most of the newer devices have computers and rebooting correctly may correct some operational problems.

Recording systems: Recognizing a recording problem and recovering from it is critical to good operations. As an operator, it is usually much faster to recover from a problem then to diagnose it. What I mean is that of a Mark6 recording system is giving you errors it may be best to attempt to follow a full reboot procedure then to begin diagnostic testing to determine what exactly failed. Remember all of these devices have a computer within them and following a reboot procedure may recover your system to begin operating.

Lost channels: In the older system like the Mark4 having video converters, the analysts have instructed us which channels are most important to lose first due to failure. This is also true with the newer RDBE systems. With these systems the first band you should lose is channel C. So if you have a band which has a failed RDBE or UDC you should attempt to make you system function with bands A,B,D allowing Band C to have the bad component. The catch with this is that if your failed RDBE is not streaming data your Mark6 will not record unless it see 4 channels of data. Modifications under the direction of experts is necessary to confirm this.