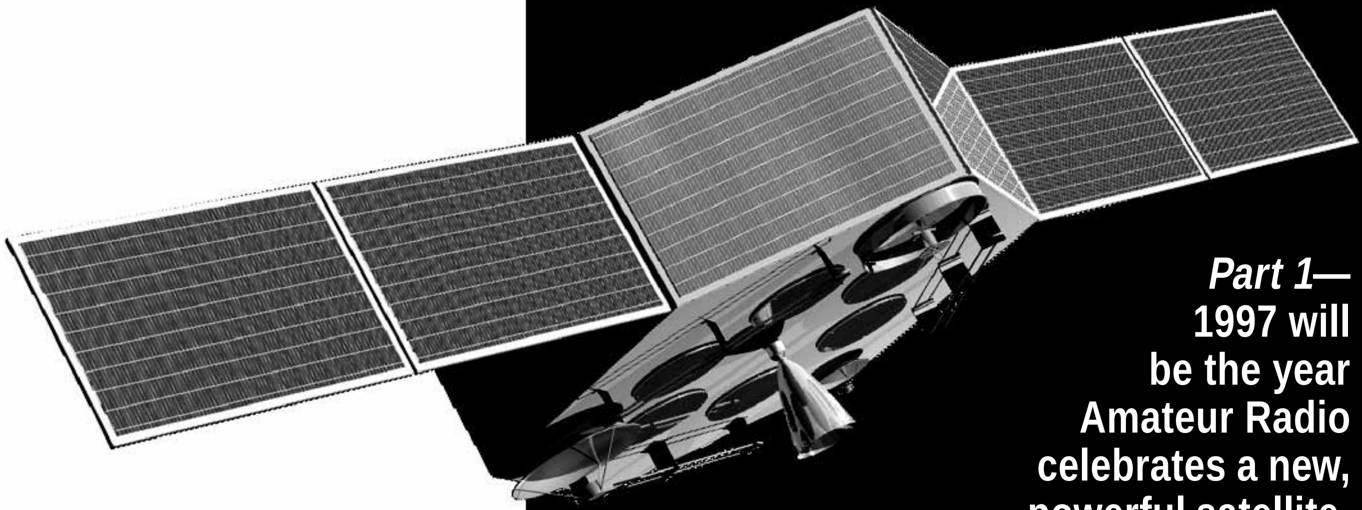
By Steve Ford, WB8IMY

Get Ready for Phase 3D!



Part 1—1997 will be the year Amateur Radio celebrates a new, powerful satellite. Will you be ready?

Date: April 1997

**Location: Centre Spatial Guyanais (CSG)
Kourou, French Guyana**

The Ariane 5 rocket waits on the launch pad, growling and seething like a caged beast. Cryogenic pumps whine as torrents of liquid hydrogen and oxygen pour into Ariane's cavernous fuel tanks. Its side-mounted solid-fuel boosters remain silent—for now.

At T minus 6 minutes 30 seconds, launch computers take complete control. Now Ariane's human masters can only watch and wait. A single voice counts down the remaining minutes in French.

A few seconds before zero the Vulcan main engine comes to life. Ariane struggles against its restraints as the thrust builds to take-off power.

Zero! The boosters explode in incandescent fury. Shock waves ripple through the billowing exhaust, causing distant trees to sway and sending flocks of frightened birds scattering skyward. From the control center technicians watch anxiously as the second flight of Ariane 5 climbs slowly off the launch pad.

To everyone's relief, telemetry and radar show the rocket on course, heading east and accelerating to supersonic velocity. One hundred and twenty-five seconds later, at an altitude of about 36 miles, the boosters are exhausted. They fall away from the fuselage while the main engine continues to burn.

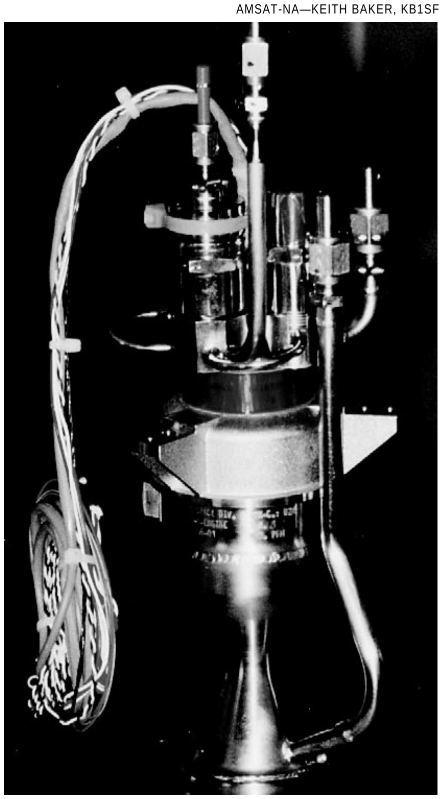
At T plus 10 minutes, the Vulcan engine falls silent and the stages separate. The second-stage engine ignites. As the rocket streaks into the blackness, the nose-cone fairing that has protected its precious cargo from atmospheric friction is no longer needed. It disengages and plummets earthward.

At T plus 24 minutes the second-stage engine shuts down. Soon thereafter, a satellite detaches and glides into space. The departing "passenger" is *Phase 3D*, the largest and most complex Amateur Radio satellite ever created.

Even though the giant satellite has achieved *transfer orbit*, its journey is far from over. Now the Phase 3D teams shift into high gear, testing various systems to make sure they survived the ride to space. When all is ready, they send the command that ignites the main engine, hurling Phase 3D into a high, elliptical orbit. More tests and engine firings follow as the satellite is nudged into its precise orientation.

At long last—about 90 days after it left the confines of its mothership—Phase 3D opens for general use, fulfilling the dreams of thousands of hams throughout the world. Of course, we'll be calling it an *OSCAR* by that time: *O*rbiting *S*atellite *C*arrying *A*mateur *R*adio. Assuming that another Amateur Radio satellite isn't launched before it, Phase 3D will become OSCAR-31.

AMSAT-NA—KEITH BAKER, KB1SF



A close-up view of the business end of Phase 3D's 400-Newton kick motor. The engine burns a mixture of hydrazine and nitrogen tetroxide to propel Phase 3D to its final orbit.

Figure 1—The Earth as seen from OSCAR 13 (as depicted by *InstantTrack* satellite-tracking software). In this view, the satellite is centered over the Pacific southwest of Peru. When OSCAR 13 was in this position, nearly every satellite-active ham in the continental US could work stations throughout the Caribbean, Central America, South America and a large portion of the South Pacific.

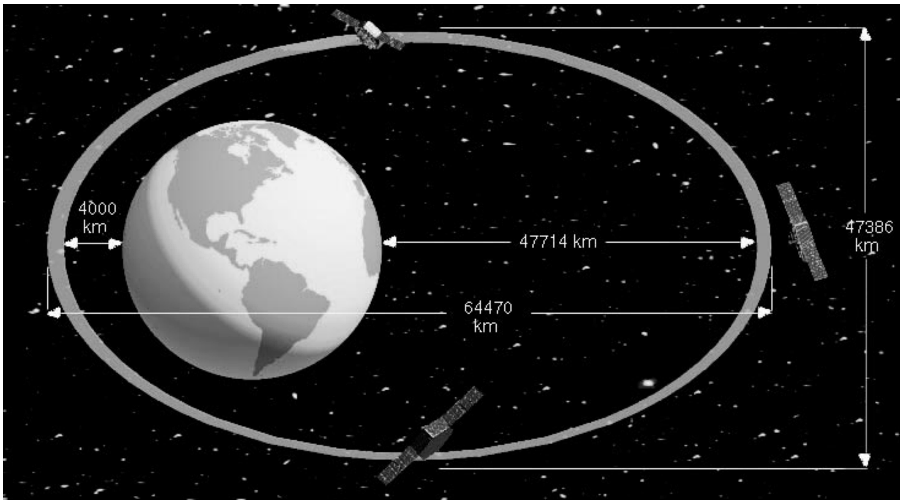


Figure 2—Phase 3D will travel in an elliptical orbit with a maximum altitude of almost 30,000 miles (48,270 km). Imagine how much territory the satellite will "see" from that height!

The Late, Great OSCAR 13

To understand Phase 3D you must know the story of OSCAR 13. The satellite is just above my horizon here in Connecticut as I'm typing these words. By the time you read them, however, OSCAR 13 will be little more than a memory.

Launched in 1988, OSCAR 13 quickly became the most popular satellite in Amateur Radio history. It traveled in an elliptical orbit that sent it about 22,000 miles into space at its greatest distance from Earth (its *apogee*). From that vantage point, OSCAR 13 could "see" huge portions of the globe (Figure 1). Any station within its *footprint* could use the satellite as a relay to work anyone else within that footprint. Its *transponders* functioned like repeaters in space, except that they could relay many signals at once. When the satellite was positioned over the Atlantic, for example, hams east of the Mississippi could enjoy SSB and CW conversations with hams in Europe, the Middle East and much of Africa.

Any tracking program could be used to determine when OSCAR 13 was in range, but there was an extra complication: Every 90 days the satellite shifted its orientation in space so that its solar cells could receive sufficient sunlight. When it did, its antennas would point away from Earth, making it difficult to use the bird. So, not only did you have to know when you were within OSCAR 13's footprint, you had to determine where its antennas were pointing relative to your station. This was the so-called "squint angle" or "off-pointing angle."

Also, OSCAR 13 was equipped with several transmitters, but they were not very powerful. This meant that most OSCAR-13 users needed sizable antennas.

But despite these difficulties, OSCAR 13 never had a shortage of activity. On weekends in particular, the downlink sounded like 20 meters. DXpeditions would bring satellite equipment and treat OSCAR 13 like another "band," generating huge pileups!

More Than a Replacement

To say that Phase 3D is a mere replacement for OSCAR 13 is like saying that a new Ferrari is a "mere replacement" for a Ford Taurus.

Consider the output power of Phase 3D's transmitters, as compared to OSCAR 13's. On 2 meters, OSCAR 13 managed to generate about 50 W PEP. On the same downlink, Phase 3D will pump more than *100 W PEP* to an 11-dB gain antenna. On its 2.4-GHz downlink, OSCAR 13 produced a single watt of output. On 2.4 GHz, Phase 3D will furnish *50 W* to a 19-dB gain antenna!

With Phase 3D's substantial output power and high-gain antennas, you won't need large

Table 1
Phase 3D Frequencies

Note: These are inverting transponders. For example, if you transmit upper sideband in the lower portion of the uplink passband, the satellite repeats in lower sideband in the upper portion of the downlink passband.

UPLINKS

Band	Digital (MHz)	Analog (MHz)
15 meters	—	21.210–21.250
2 meters	145.800–145.840	145.840–145.990
70 cm	435.300–435.550	435.550–435.800
23 cm (1)	1269.000–1269.250	1269.250–1269.500
23 cm (2)	1268.075–1268.325	1268.325–1268.575
13 cm (1)	2400.100–2400.350	2400.350–2400.600
13 cm (2)	2446.200–2446.450	2446.450–2446.700
6 cm	5668.300–5668.550	5668.550–5668.800

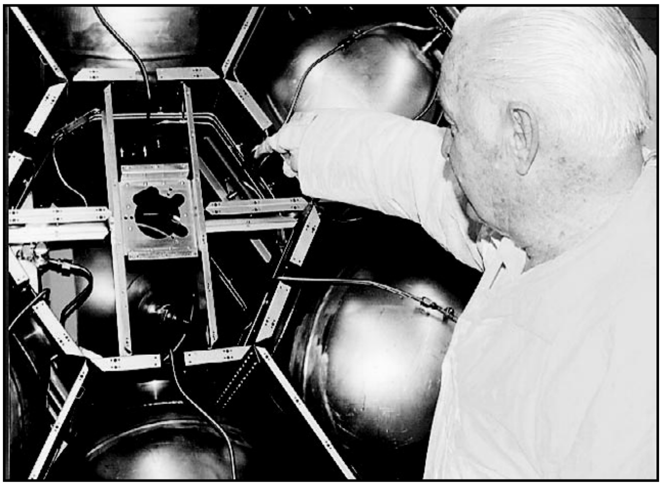
DOWNLINKS

Band	Digital (MHz)	Analog (MHz)
10 meters	none	29.330 MHz (To be used for AM voice bulletins)
2 meters	145.955–145.990	145.805–145.955
70 cm	435.900–436.200	435.475–435.725
13 cm	2400.650–2400.950	2400.225–2400.475
3 cm	10451.450–10451.750	10451.025–10451.275
1.5 cm	24048.450–24048.750	24048.025–24048.275

BEACONS

Band	Beacon 1 (MHz)	Beacon 2 (MHz)
70 cm	435.450	435.850
13 cm	2400.200	2400.600
3 cm	10451.000	10451.400
1.5 cm	24048.000	24048.400

AMSAT-NA—KEITH BAKER, KB1SF



Chuck Hennessey, W4AT, explains the Phase 3D fuel-delivery system. The round objects are fuel tanks.

Phase 3D is a cooperative, international project. Here the Phase 3D project workers meticulously check drawings and schematics at the AMSAT-DL Laboratory in Marburg, Germany. From left, Dick Jansson, WD4FAB, AMSAT-NA Vice President, Engineering; Karl Meinzer, DJ4ZC, AMSAT-DL President and Phase 3D Project Leader; Peter Guzelow, DB2OS; and Werner Haas, DJ5KQ, AMSAT-DL Vice President.

antennas on many bands, or great amounts of RF power on *any* bands. That translates into smaller, more affordable stations—particularly if you make the leap to microwaves. Apartment dwellers and hams suffering under antenna restrictions will appreciate this!

When it comes to uplink and downlink frequencies, Phase 3D has phenomenal flexibility (see Table 1). The transponders can be mixed and matched as the need arises. For example, the satellite could be configured to listen on 70 cm and relay on 10 GHz. Or listen on 1.2 GHz and relay on 24 GHz. Or…well, you see what I mean. And if the power budget is as great as expected, Phase 3D will operate in two uplink/downlink modes *simultaneously*. (We'll know if this will be possible once the bird is in final orbit and all tests are complete.)

If everything goes as planned, Phase 3D's orbit will be higher at apogee and more stable than OSCAR 13's (see Figure 2). It may also allow the satellite to perform a neat trick. That is, Phase 3D may appear in the same position in your local sky every 48 hours. If the satellite is 10° above your neighbor's apple tree at 8 o'clock on Monday morning,

Phase 3D Questions and Answers

Q: Who owns Phase 3D?

A: No single group or country owns Phase 3D. It is a truly international satellite, created through the efforts and financial contributions of hams from the United States, Germany, Great Britain, Japan, Russia, Hungary, Belgium, South Africa, the Czech Republic, Slovenia, Canada, Finland and France.

Although Phase 3D will be a satellite that hams all over the world can use, like any amateur station, it must be licensed in a specific country. In the case of Phase 3D, as it was with OSCAR-13 and still is with OSCAR-10, the country of license will be Germany. This is because the original concept for the satellite came from that country and because Phase 3D will be launched on a European rocket.

Q: Why can't I use FM through Phase 3D?

A FM is a 100% duty-cycle mode. In other words, an FM transmitter generates full output whenever it's in use. Phase 3D would need an enormous power source to produce FM signals that could be heard at a distance of nearly 30,000 miles. Not only that, because of the considerable bandwidth of an FM signal, the number of simultaneous conversations per transponder would decrease dramatically.

Q: Who decides which modes will be active and when?

A: The groups that made the largest financial contributions to the construction of Phase 3D will each have a representative on the satellite's controlling board. This board will design the operating schedule for the satellite. When this article went to press, DARC, AMSAT-DL, AMSAT-UK, AMSAT-NA and the ARRL all had "seats" on the board.

The control board will issue "guidance" to the Phase 3D command stations regarding the satellite's operating schedule. However, the command stations will carry ultimate responsibility for the health of the satellite. Health issues must, of course take priority.

It's worth noting that some of the mode designations have changed. Here is a sampling of the possible configurations for Phase 3D:

Mode	*Uplink (MHz)*	*Downlink (MHz)*
U/V	435	144
V/U	144	435
U/S	435	2400
L/U	1,200	435
L/S	1,200	2,400
L/X	1,200	10,500
C/X	5,600	10,500

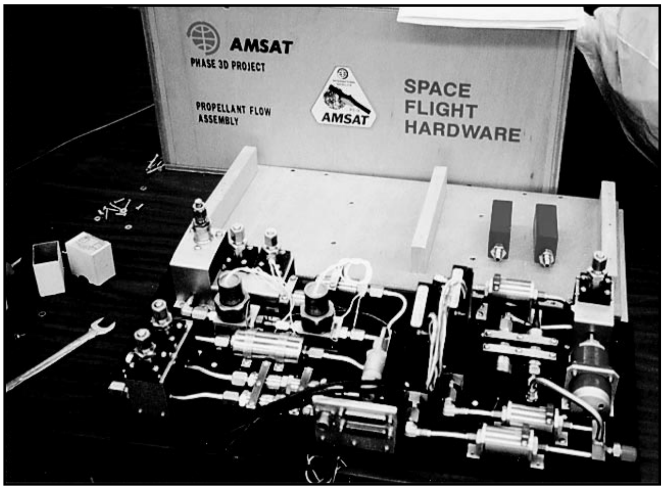
Q: I presently own a Mode-B station that I used with OSCAR 13. Can I use it with Phase 3D?

A Yes. Mode U/V through Phase 3D is the same as Mode B.

Q: Why does Phase 3D travel in an elliptical orbit? Why not make it a geostationary satellite?

A Launching a satellite into geostationary orbit and maintaining it there is very expensive. Governments and large corporations have the funds to pull it off, but not amateur satellite organizations. If an AMSAT group *did* decide to pursue a geostationary satellite, it couldn't expect much help from hams in other countries. A geostationary satellite positioned to cover, say, North and South America, would be useless to hams in much of Europe, Asia and Africa. They would have little incentive to contribute to its creation!

Instead, Phase 3D will travel in an orbit that allows *all* hams to benefit. Using Earth's gravity like a slingshot, it will soar into space and appear to "hover" for hours above a particular portion of the globe. Then, it will dive back in and shoot outward once again to hover over yet another area.

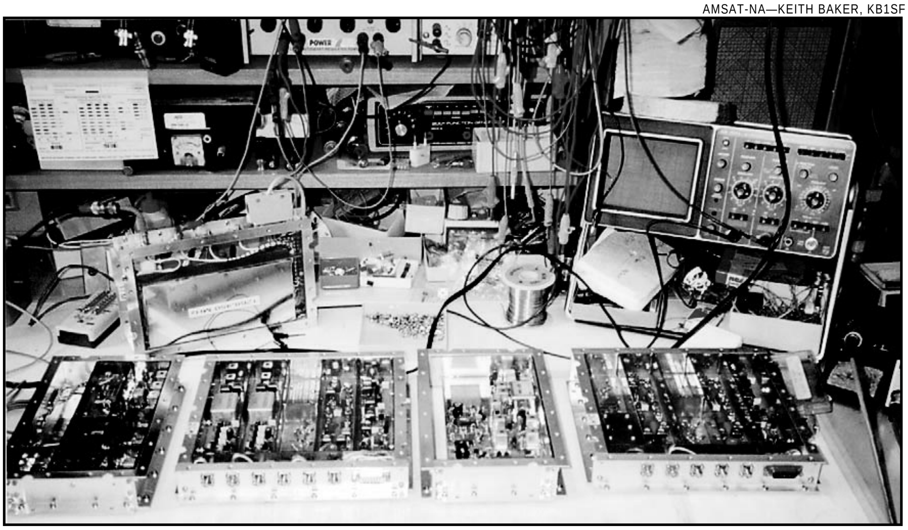


The propellant flow assembly arrives in Orlando, ready for installation into Phase 3D.

Phase 3D Features

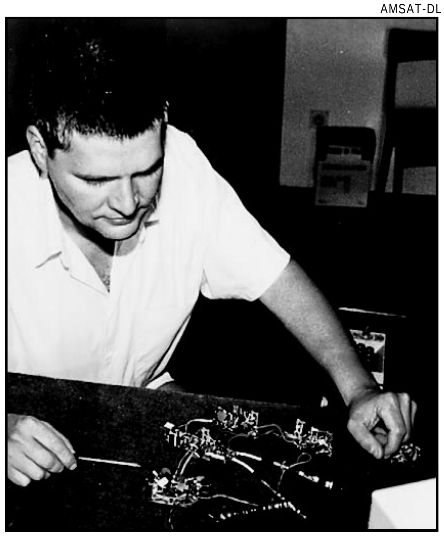
- Uplinks and downlinks on six bands, from 15 meters to 24 GHz.
- Powerful, wide-bandwidth transponders supporting many simultaneous SSB or CW conversations.
- AM voice bulletins on 10 meters receivable with common shortwave radios.
- On-board color video cameras. (Download spectacular images from 30,000 miles up!)
- Sophisticated on-board Global Positioning System (GPS). Phase 3D will generate and transmit its *own* orbital elements.
- Digital communication up to 56 kbaud.
- An orbital track that places the satellite at the same points in your local sky every 48 hours.

AMSAT-NA—KEITH BAKER, KB1SF



Some electronic modules for Phase 3-D undergo final bench testing at the AMSAT-DL Laboratory in Marburg, Germany prior to their shipment to Orlando, Florida for integration into the satellite.

AMSAT-DL



Matjas Vidmar, S53MV, is shown experimenting with prototypes of the LEILA circuit for the Phase 3-D satellite at his workshop in Slovenia. It is designed to alert ground station operators who inadvertently run too much uplink power by superimposing a warning message on the "offending" station's downlink signal.

it would be there again at 8 o'clock on Wednesday morning. This doesn't mean that you can throw away your satellite tracking software, but it certainly won't be as critical to your station.

Phase 3D may also dispose of the squint-angle problem that bedeviled the OSCAR 13 community. If the large solar panels deploy properly, Phase 3D *won't* have to reorient itself periodically for proper Sun exposure. Instead, it will keep its antennas pointed directly at the Earth at all times. Translation: If Phase 3D is above your horizon, you can probably use it.

Like the cheesy commercials on late-night TV, I could keep saying, "But wait! There's more!" The main point, however, is this: Phase 3D is a communication *engine* totally unlike any amateur satellite that has come before. Its effects on Amateur Radio will be profound—particularly among hams licensed to the Technician class.

What It All Means to You

Phase 3D will open the door to long-distance communication regardless of solar conditions. Whenever the satellite is above your horizon, the band will be "open" for you. And I'm not talking about chats over a few hundred miles. Each time the satellite is at apogee, half of the Earth's disc will be "visible" to its antennas and wide-bandwidth transponders. That's a sizable footprint, with opportunities for lots of DX.

Technician-class amateurs will be among the big beneficiaries of Phase 3D. The satellite will open the world to them, allowing many to work DX on a *regular basis*. After Phase 3D reaches orbit, we'll have to make room for many more Technicians on the DXCC rolls!

Phase 3D will also function as an ideal platform for those who want to extend their horizons into the microwave bands. Imagine being able to receive the satellite's 24-GHz downlink using a tiny, two-foot dish. How about a portable microwave satellite station that fits into a standard suitcase? We desperately need more activity on our microwave frequencies and Phase 3D will give hams a powerful incentive.

Tune in Next Month

If you've read this far you must be eager to start planning and building your own Phase 3D station. Well, you're in luck! In subsequent issues we'll offer practical advice on station equipment and design for various uplink/downlink combinations—beginning next month with 2 meters and 70 cm. QST