MRAC Hamateur Chatter

The Milwaukee Radio Amateurs Club

June 2017 Volume 25, Issue 6

100 Years, 1917—2017 The oldest Continuous Ham Radio Club in the United States

Field Day 2017

Join us for the ARRL Field Day June 24&25, 2017. MRAC, MAARS, and LEFROG Radio Clubs will set up at MATC Oak Creek Campus. The site is located in the Police and Fire Science training area behind the main building.

Hi Guys,

We had a productive meeting Saturday, June 10th, at the site. This year we will again attempt to run 4A. If you have something you would like to experiment with please feel free to bring it. All I ask is you let us know of your plan so we can make room for it.

MAARS will provide the RV and network equipment. This will be the phone station and we will use Kenwood TS-2000 attached to the LEFROG beam and rotor.

CW station will be setup in the classroom area. We will use the LEFROG IC-9100 radio and beam antenna. Rotor will supply his rotor.

VHF/GOTA station will setup in the common tent area just outside the RV. Radio will be an FT-100D and the rotatable 10-40M dipole antenna. Rotor supplied by W9BLS.

KC9IJJ (Disco tent) Al will provide his station equipment. The antenna will be an R7 vertical.

W9BLS (N9MKX) trailer will supply its own equipment and R7 antennas.

This year I should have 6 computer available for logging.

LEFROG will bring some extra coax this year. (**Google Site Map at end of newsletter)**

Dave KA9WXN

MRAC Officers:

Terms Expiring in 2018

- President – Dave, KA9WXN
- V-President– Vacant
- Secretary – MBH, KC9CMT
- Treasurer – MBH,,KC9CMT

Terms Expiring in 2017

- Director – vacant
- Director – Vacant
- Director – Tom, W9TJP
- Director--Dale, AB9DW

The Club Phone Number is: (414) 332-MRAC or

(414) 332- 6 7 2 2

Visit our website at:

www.w9rh.org

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Board of Director's Minutes

Board of directors meeting called to order at 7:00 pm by Dave Shank, KA9WXN club president.

Director's present: Michael KC9CMT, Dave KA9WXN, Tom W9TJP, Barry W9BLS.

Absent: Al KC9IJJ, Dale AB9DW, Dave KA9FUR, two vacancies on the board.

Preliminary Discussion: Barry W9BLS is sitting in on the board this month. The Treasurers report for May 2017 was presented by Michael, KC9CMT. The treasurers report was approved as read by KC9CMT, a motion to accept was made by Tom, W9TJP, seconded by Barry W9BLS. The May balance ended with $19,843.97 in club accounts. New member certificates will be mailed, if not handed out at the membership meeting when they become available.

Meeting Presentations: Tom brought up the idea of an email server, mail chimp, or Email Blast, to send out reminders along with the monthly chatter. The May presentation will be conducted by Dave, WB9BWP, which is the annual MRAC auction. There should be seven board members. June will be a field day rap up discussion. The people from Milwaukee solar energy have said they would be willing to do another presentation to the club. Another good topic is lightening protection, and radio specifications. The board members have been discussing getting together over the summer break to put together stations in various parks and operate.

Field Day: Field day 2016, went well at the MATC facility. MATC has both port-a-potties and hand wash stations at the location. It's a good location, and will be available for us in 2017. The board would like to have a working committee for the 2017 field day effort. Food will be offered on Saturday, either night or afternoon. Menu has yet to be determined. The LEFROG, MATC RC, & UWM ARS groups has been invited to share the MRAC/MAARS field site with us. A special banner will be purchased for this years field day, stating the 100th anniversary year.

Special Project Committees & Committee reports:

Repeater Report: The club would like more than one repeater control operator. A club repeater control operator should be a extra class operator to have the kind of privileges that are necessary to operate field day to its fullest extent.

New Business: The Board will be having our meetings at the HRO in 2017. Dave, KA9WXN is continuing discussions regarding events for the clubs' 2017 100th anniversary. Tom, W9TJP reports that Ham Radio Outlet is open from 10am-5:30pm, Monday through Saturday. The banquet will be catered. Kermit Carlson will be the featured speaker at the banquet, date October 21st, 2017. JOTA is the same day as the banquet.

The Annual picnic is **August 12th, 2017**, at Picnic area 2, Greenfield park. The club does have a Twitter account, along with our Facebook account.

100th Anniversary: The venue has been decided on as being Carl's, the maximum capacity is between 250-300. Carl's will be doing the catering. An invitation list is now being discussed, and needs to be completed as soon as possible after field day this June. A general announcement sheet should be ready by the July 8th, 2017 SMARC Hamfest. The board needs to compile a VIP list for the banquet and send out invitations.

Special event stations for 2017. Dave, KA9WXN will attempt to generate interest among the membership in forming a committee to handle planning. Dan, N9ASA has arranged with The House of Harley Davidson to have a special event station during their annual bash on June 17th, 2017. Makers-Faire 2017 will have a special event station, at our club booth, from State Fair Park. JOTA coordinator KC9WW Fred, is helping the club to format an event at the Indian mounds, in Oconomowoc.

Swapfest committee: The club is looking at April 1, 2018, as the MRAC/MAARS swapfest date. The Elks club is a smaller venue, but will hold as many tables. The Boy scouts of America will be offering food. We expect about 43 tables to be rented to vendors. The board has moved the Swapfest to April 1st, as a guard against losses due to inclement weather. Name: "Spring Fling" 2018 will be our 8th annual swapfest.

Special Projects: A special event station will be June 17th, at Greenfield House of Harley dealership. Dan N9ASA is handling this project. The special event will run during the dealerships hours of operations. The club needs someone to take over the FM simplex contest for February of 2018. The club really needs PR and recruitment. The North Point lighthouse is the property of the Milwaukee Historical Society. The club would like to have a special event station setup there this summer. The lighthouse event in Port Washington is on August 19th. We should attempt not to conflict with this yearly sponsored event. The board of director's has set the date of October 21st, 2017 for the MRAC 100th anniversary banquet, to be catered for a crowd of 200. A special event station at the lakefront is being worked on by Dave, KA9WXN. The club will be sending letters to former members asking if they would like to renew for 2017, our 100th anniversary year. This will allow our past members to take part in all the activities being planned. Dave, WB9BWP will be sending anniversary information to Gordon West for his weekly Ham Nation Broadcast.

A special event station at the War Memorial is being discussed. The club will use the club call of W9RH/100 for all our special events. The club needs to have some special QSL cards, or ridged certificates printed up for contacts during the calendar year of 2017. The club would like to query members about working on projects for the 100th anniversary. Makers-Faire is on September 23-24th, 2017. JOTA 2017 will be another event the MRAC will be involved in. The club will be putting together a go kit for taking to various events.

Website update: The club has a Wiki page. Dave, KA9WXN has been working on a 100th anniversary page. Two new people have been added as administrators for the WordPress powered club website. Dan, N9ASA, & Dale, AB9DW.

Clubs throughout the country need to use the spectrum that they have been given. The 220mhz band is not used very often in the Milwaukee area. DMR is now becoming a item among Hams'. The FCC has granted radio Amateurs' two more band segments recently, 2200mhz, & 603mhz.

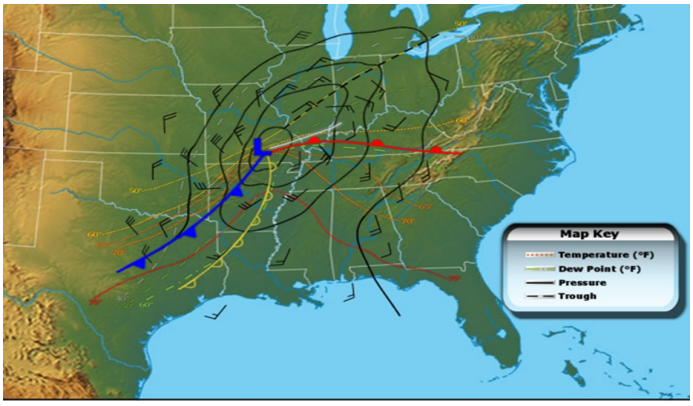
A motion was made to adjourn the meeting at 8:50 pm by Tom W9TJP seconded by Michael, KC9CMT. Meeting adjourned at 8:55 pm.

March 18, 1925 — The Tri-State Tornado

Deep in the Ozark Mountains, in places scarcely changed through nine decades, there are legends of a monster. Though few, if any, still live to tell the tale first-hand, the tradition persists, straddling the line between fact and myth. In the Shawnee Hills of Southern Illinois, too, old-timers pass on the legend. Indeed, across three states and more than 200 miles, folks of a certain generation recall harrowing accounts by those who witnessed death drop from the sapphire sky one balmy pre-spring afternoon in 1925. Over three and a half hours, the Great Tri-State Tornado roared through the southern portions of Missouri, Illinois and Indiana, wiping town after town off the map as it ripped through forests and farmlands, over peaks and hollows, and across the mighty Mississippi River at speeds sometimes exceeding 70 mph. When the greatest tornado disaster in recorded history finally came to an end some 219 miles later, 695 people laid dead and more than a dozen towns and hundreds of farmsteads were left in splinters.

The morning sky was odd, choking the sun out with blankets of low, leaden clouds. The ground was soft and spongy from the pitter-patter of rain that had broken out just before dawn, and although the skies had begun clearing up as the noon hour approached, intuition told 49-year-old Samuel Flowers that more was to come. As with most other residents in the hills and valleys north of Ellington, Mo., Sam had developed a keen sense for the weather through decades of working the land. Despite the dreary morning, a steady south-southeast wind had ushered in unseasonably balmy temperatures. The whites and pale pinks of wildflowers had already begun to sprout up across the rolling, muted brown fields, and the sun sparkling through mostly cloudless skies created the distinct impression that a beautiful spring day was in store for the Mid-Mississippi and Ohio Valleys. But Sam knew better. Just before 1:00pm, rumbles of thunder rolling in from the southwest confirmed his suspicion — a storm was coming.

What Sam Flowers couldn't know as he urged his horse toward home was that a broad area of low pressure had descended from Canada several days earlier and begun to deepen in the lee of the Rocky Mountains. After dropping southeast into the Central Plains the previous day, the fully-developed cyclone began pulling in vast quantities of warm, moisture-laden air on its eastern flank as it accelerated toward the Ozarks. Directly to the east of the surface low, a warm front pushed north across the Ohio River and into southern Illinois. A dryline extended to the south, with a weak cold front trailing to the southwest. Higher in the atmosphere, a fast-moving shortwave trough traversed the Rockies and began to dig into the Central and Southern Plains and take on a slight negative tilt. At the same time, a strong jet streak nosed into the Ozarks from the southwest. Warm, dry air in the mid-levels spread east across the Mississippi, setting up a strong capping inversion.



A composite surface map from 18z (12pm), about an hour before the tornado formed. Pressure, wind observations, temperature, dew points and approximate locations of fronts are shown. The track of the tornado is indicated by the white line east of the low. As the low progressed during the afternoon and evening, it followed roughly along the pressure trough to the northeast (black dashed line).

Thunderstorm activity began just after midnight as several cells erupted to produce large hail across eastern Oklahoma and Kansas, as well as a brief tornado that damaged several structures west of Coffeyville. Light rain broke out shortly before daybreak across much of Missouri, Illinois and the southern half of Indiana, creating a pool of rain-cooled air to the north of the advancing warm front. By midday, the surging warm front had brought temperatures into the middle and upper 60s. Plumes of unstable air near the surface began to rise into the atmosphere, eventually bumping into the warm, dry cap. Just minutes after noon, near the triple point where the warm front, cold front and dryline merged in south-central Missouri, a lone thunderhead burst into the sky. Whipped and twisted by the strong wind shear throughout the atmosphere, the thunderstorm quickly became super cellular as it raced northeastward.

Shortly before 1:00pm, a low, ragged cloud descended over the forests northwest of Ellington in Reynolds County, Mo. As Sam Flowers spurred his horse on toward his farmhouse, a low rumble grew on the horizon. The sky to the southwest had grown dark and menacing, and a warm wind had begun whistling through the tall oaks and shortleaf pines. The horse, affectionately named Babe, broke into a full gallop as Sam grasped desperately at his saddle horn. Large hailstones pummeled the earth and left divots in the soft grass. Within seconds, the distant rumble bore down with a tremendous roar. What happened next is not clear, but a short while later Babe returned to the Flowers farm without her rider. Sam was found several hours later some distance from the road, his head smashed beneath a tree. The most devastating tornado in United States history had claimed its first victim.

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In the small mining village of Annapolis, most residents had just returned to work from their lunch breaks. Just east of town in the tiny outpost of Leadanna — named after the ubiquitous mineral harvested throughout the area — many of the men had returned to toil in the mines deep below ground. Children had just been called in from recess at Annapolis School and were streaming back into the small, two-story brick structure. The first indication of trouble came from residents just outside of town, who were afforded a relatively clear view of the rolling hills to the west. The skies in that direction had taken on a strange, bruised appearance, the type that often preceded the strong storms that lashed the region at least a few times each spring. Suddenly, a murky figure emerged atop the nearest hill. More resembling a great, billowing fog than a funnel cloud, the tornado ripped through the valley and engulfed the tiny town and its residents in seconds.

The children at Annapolis School became frightened by the rapidly deteriorating weather. The sun disappeared in a torrent of rain and hail. Wind shook the trees outside the schoolhouse windows. The teacher, fighting back her own trepidation, gathered the children around her desk in an attempt to comfort them. The cries of the 25 students were drowned out by the furious roar as the tornado blasted through, taking just seconds to reduce much of the brick schoolhouse to rubble. Miraculously, all of the children survived with only minor injuries. The mines in Leadanna also sustained heavy damage. Offices, medical buildings, grocers and other structures were destroyed, and much of the mining machinery was ripped up and mangled beyond repair.

The lead mines in Leadanna after the tornado had passed.

As the school children and the miners rushed back to town to check on their families, they were greeted with a scene of total devastation. Residents wandered in a daze. Children cried for their parents. Survivors climbed out from mountains of broken timber and other debris. Those who witnessed the aftermath later recounted that, of the town's approximately 400 buildings, more than 90 percent were damaged or destroyed. The tornado was likely only of moderate intensity as it struck the town, but it left a trail of damage perhaps a mile wide. Four people were killed in all, two in Annapolis and two in Leadanna who were caught above ground and struck by flying timbers.

A marriage certificate for Nell and Osro Kelly, the latter of whom was among the tornado's victims, was later found 77 miles away in Murphysboro. The local lead industry was nearly ruined. The mine continued to operate in limited capacity until the 1940s, but it never again matched the production it had achieved before the tornado.

A general store in downtown Annapolis was left splintered, scattered among the ruins of hundreds of other homes and businesses. Red Cross tents for survivors can be seen in the background on the left.

Because of its resemblance to the low hills of southwest Germany's Black Forest region, the Ozark hills of Iron, Madison and western Bollinger Counties were populated largely by German immigrants. Most had become farmers, and the grapes that many of them grew were among the finest in the United States for producing high-quality wine. The terrain was rough, forested and sparsely populated, leading to a number of gaps in the documented track of the tornado. It's not clear whether any of the gaps represents an actual break in the tornado path, but what is clear is that, where the swirling vortex *did* strike, it had lost none of its violent intensity. Dozens of homes were destroyed across about 50 miles of Iron, Madison and Bollinger Counties, and 32 children were injured when two schools were destroyed in Bollinger County. About ten miles west of Sedgewickville in northwestern Bollinger County, grass and several inches of soil were reportedly scoured from the ground near the home of Emily Shrum, which was completely leveled.

The home of Emily Shrum, which was located on the south side of the mile-wide damage path. Ground scouring was noted nearby.

After claiming several victims in Bollinger County, the tornado struck western Perry County as a "double funnel." The massive tornado churned through the tiny village of Biehle, joined by a satellite vortex that traveled on a nearly parallel track for about three miles. Between the two tornadoes, dozens of homes were destroyed and four of Biehle's residents were killed. To the northeast, in the unincorporated community of Ridge, the Ridge Parochial School was squarely in the path of the violent twister. The wind began driving sheets of rain against the roof, and soon it blew the thick wooden door open. The teacher, determined not to let a little storm ruin her classes, ordered the students to hold the door closed against the storm. As the tornado bore down, it ripped the school from its foundation and sent it hurtling several yards into a nearby hillside. Miraculously, despite the complete destruction of the structure and dozens of serious injuries, none of the school's occupants were killed.

As the tornado tore across the more populous rolling hills and lowlands of Perry County and toward the banks of the Mississippi River, the tornado again began to claim lives. About four miles northeast of Frohna, the very large, well-built home of Perry County District Judge Claus Stueve was completely demolished. He sustained various injuries, while his wife and a houseguest were killed. Just to the west, the home and barn of Theo Holschen were obliterated and three family members were seriously injured. In total, the tornado killed at least thirteen Missourians and left a path of devastation at least 85 miles long — perhaps up to 100 miles — and at times more than a mile wide. This alone would have been an impressive feat, but far worse was yet to come. The next 45 minutes were to bring perhaps the most horrifying display of sustained tornadic violence in recorded history.

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On the Illinois side of the Mississippi River, towering riverside bluffs skirt the southern extent of a broad, flat floodplain. Fertile farmland spreads like a patchwork quilt across the plain,

broken only by a spider web of rail lines which converge on the little river town of Gorham. In 1925, Gorham was a vital stop along the Missouri Pacific and Illinois Central railroads, where coal from across the region was funneled through the rail yards on the town's south side on its way to the larger markets from St. Louis to Texas. The influx of rail traffic brought welcome business to sleepy Gorham, as general stores, restaurants, hotels and other amenities popped up to serve the railroad crews when they stopped to refuel and cool the engines. The permanent population was between 500 and 700, but Gorham was a town on the rise.

Like so many others, the first warning of the approaching catastrophe that Gorham's residents received was a dark, menacing mass of cloud approaching from atop the bluffs southwest of town. After spending nearly an hour and a half tearing across southeastern Missouri, the tornado crossed the half-mile span of the mighty Mississippi River in seconds and barreled into Jackson County in southwest Illinois. The tornado roared across the fields west of Gorham with such tremendous force that it scoured a large patch of ground, stripping the grass from the earth and plowing up several inches of soil in a shallow gully. Trees on the outskirts of town were stripped of bark and limbs, with many ripped from the ground or snapped off. Those in Gorham had only seconds to react as the thundering black mass bore down on the town at more than 60 mph.

The tornado entered town near the rail yards, throwing boxcars and demolishing the nearby depots and office buildings. A section of train tracks was torn from the ground and some of the crossties were thrown into the rubble of surrounding buildings. A row of homes and businesses along Main Street virtually exploded in a cloud of shattered timbers and roofing. The rest of the town met the same fate, as rows of homes, apartments and other buildings were reduced to rubble in a matter of seconds. One child was thrown nearly a quarter of a mile into the ruins of a business. In the words of a reporter for the *St. Louis Post-Dispatch:*

"All morning, before the tornado, it had rained. The day was dark and gloomy. The air was heavy. There was no wind. Then the drizzle increased. The heavens seemed to open, pouring down a flood. The day grew black…
Then the air was filled with 10,000 things. Boards, poles, cans, garments, stoves, whole sides of the little frame houses, in some cases the houses themselves, were picked up and smashed to earth. And living beings, too. A baby was blown from its mother's arms. A cow, picked up by the wind, was hurled into the village restaurant."

Near the center of town, a large building housed both the grade school and high school. The tornado tore off the roof and battered the thick walls, collapsing them in on the children and teachers sheltering inside. Thirteen year old Margaret Brown, daughter of school superintendent Lewis Watson Brown, was killed when she was reportedly "cut in two" by a large brass bell that had fallen from the peak of the roof. Brown's wife, Della, was also killed when their home was swept away. Two other families also suffered tremendous losses. Seventy-three year old Mary Moschenrosen and three of her adult children were killed by the swirling vortex, as were four members of the Needham family. A pair of pants containing scraps of paper bearing the name Moschenrosen were subsequently found nearly 20 miles to the northeast of Gorham. A husband and wife were thrown some distance from their home, shards of timber impaled through the wife's abdomen.

More than a dozen boxcars were thrown from the tracks on the southwest side of Gorham.

By the time the fury of the wind had passed, Gorham had become the first, but unfortunately not the last, to bear a grim distinction: 100 percent destruction. Nearly every single structure in town was damaged or destroyed, the majority of them reduced to splinters and scattered to the wind. In the chaos that followed, as would be the case in many areas, no accurate list of the dead was kept. As best as can be discerned through newspaper reports and cemetery listings, between 32 and 37 of Gorham's residents were killed and about 170 others seriously injured. Dozens of horses and cattle were also killed, and one horse from near Gorham was allegedly found at Sand Ridge, nearly two and a half miles to the northeast. In the span of minutes, thriving Gorham had been reduced to an utter wreck from which it would never fully recover.

Complete devastation near the center of Gorham. Note the trees or poles snapped off near ground level in the background.

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If Gorham was a town on the rise, Murphysboro was what it aspired to. A modest but thriving city, Murphysboro was home to more than 15,000 people in the early part of the 20th Century. The Big Muddy River, a tributary of the Mississippi, wound its way through the western part of town. Business was booming, and much of it was centered in a relatively small, densely populated industrial sector in the northwest quadrant of the city. The industrial sector was the lifeblood of the growing city, providing jobs and rapid economic growth that had made Murphysboro a fixture in southern Illinois. The city also held appeal for some because of its nonchalant attitude toward prohibition. While neighboring towns cracked down on illegal production facilities and speakeasies, alcohol was rarely difficult to find in Murphysboro.

At 2:34pm, less than eight minutes after laying waste to the town of Gorham, the monstrous storm thundered into the southwest edge of Murphysboro. After leveling a number of homes outside of town, the tornado crossed the Big Muddy River and almost immediately began destroying homes along Clay and Dewey Streets. At Lincoln School, where children had recently been called in from recess, the windows shattered almost simultaneously as the outer fringe of the circulation passed to the northwest. A wall on the second floor collapsed and crumbled outward. Thanks to the quick thinking of the school's officials, however, students were moved to the northwest corner of the building and there were no injuries. Just to the north and closer to the center of the path, enormous hardwood trees were snapped just feet above ground level. Some were stripped bare, or uprooted and thrown hundreds of feet.

A view of the damage in southwest Murphysboro, possibly along Dewey Street.

A colorized image of a demolished home in Murphysboro.

As the tornado approached the intersection of Walnut and 20th Streets, the damage became catastrophic. Several rows of homes were completely demolished with some partially swept away, and trees in the area were debarked and denuded. Six members of the Miller family, including children of one, three, five and nine years old, were killed at one home along Walnut Street when their home was completely flattened. Along Logan Street to north, 17 children were killed when the Longfellow School partially collapsed from the force of the wind. The Mobile and Ohio Railroad shop and roundhouse, about a block to the east of the school, was severely damaged. Some workers survived by taking shelter under the heavy machinery and structures, but 35 were killed by building collapses and flying debris. A number of locomotives were rolled or thrown from the tracks, causing further death and destruction.

At 15th and Logan, a funeral was in progress in the basement of the First Baptist Church. Construction had been in progress on the church building and was nearing completion at the time. According to the Reverend H. T. Abbott, he had just begun reciting the popular funeral sermon "Yea, though ye walk in the valley and the shadow.." when a "thunderous noise" overtook the church and collapsed a large section of the sturdy building. Being assembled in the basement, there were no injuries among the funeral crowd. Immediately upon exiting the rubble of the building, however, the funeral-goers was confronted with a sight of utter devastation. About a block to the northeast, the Logan School had suffered heavy damage. Many in the crowd sprinted to the school to aid in rescuing children and staff from the rubble. Nine children were killed at the Logan School.

The First Baptist Church, where a funeral was interrupted by the tornado.

The tornado continued northeast, chewing through the residential heart of the city. Hundreds of homes were completely leveled, crushing or throwing those inside. Many families suffered multiple casualties. When a horse and buggy was caught in the tornado near Manning Street, the horse was found more than half a mile away. The buggy was never found. In all, at least 120 city blocks were completely demolished by the tornado's unbridled fury. Once the tornado had passed, another disaster began to unfold. Coal-burning stoves throughout the city, toppled or thrown by the wind, ignited fires that quickly turned the shattered piles of rubble into a great inferno. Many of those who were fortunate enough to survive the initial onslaught burned to death as the fire erupted out of control. Eighteen people were killed by fire at the Blue Front Hotel after becoming trapped in the basement.

A panorama view of the devastation in Murphysboro. The combination of tornado and fire reduced virtually the entire west and north sides of town to rubble.

By the time the fires had been extinguished, Murphysboro was in ruin. Two hundred and thirty-four people laid dead, the largest death toll in a single city in United States history. More than 600 others were seriously injured. According to contemporary reports in local newspapers, various receipts, checks, certificates and other paper items from Murphysboro were found as far away as Bloomington, Ind., 180 miles to

the northeast. The industrial sector of the city was destroyed, as was the railroad and many of the businesses in town. The tornado had torn a complex path of destruction through the city nearly a mile wide. In some cases moderately damaged homes stood across the street from areas of total devastation, suggesting the tornado had a multivortex structure. A number of homes well to the south of the primary path also suffered moderate damage, apparently caused by intense inflow or rear-flank downdraft winds associated with the supercell. The tornado had already tracked more than 110 miles and claimed nearly 300 lives, yet a full two hours of death and destruction still lay ahead.

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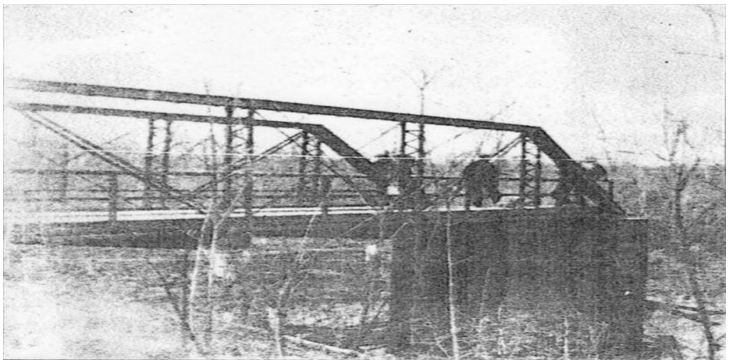
After exiting Murphysboro, the tornado tore across the countryside with undiminished ferocity. The Will School, about two miles northeast of town, was razed to its foundation. A few miles beyond the school, Electra Beasley and her son Richard were killed when their farmstead was destroyed and swept away. The tornado narrowed slightly as it approached the west side of De Soto, but its destructive power was on full display. As in Murphysboro, whole sections of homes were completely flattened and swept away. Trees were debarked, denuded and snapped, leading one resident to remark that "not a tree was left standing taller than a man's knee" in the main damage path. One couple was killed when their car was thrown 50 yards from the main highway. Several other vehicles were thrown or rolled and left completely mangled, and wind rowing of debris was evident in several areas.

At the Albon State Bank, many residents took shelter in the reinforced concrete vault. The bank and surrounding buildings were largely destroyed despite being on the southern edge of the worst damage, but those who sheltered inside survived. Many others in town were not so lucky, as 36 lives were lost in the devastation of downtown De Soto. An even greater tragedy was looming, however. At the De Soto School just northeast of downtown, the threatening skies prompted officials to rush the children in from recess. The girls were quickly ushered back to their desks, while the boys were assigned to close the many windows along the outside walls of their classrooms. Moments later, the windows exploded in a hail of shattered glass and debris.

A panorama taken from a rooftop near the current location of Route 149 and facing approximately southeast. At center is the Albon State Bank vault.

Battered by the extreme wind, the top floor and a number of walls collapsed. Tons of bricks crumbled and fell atop the schoolchildren and faculty inside, crushing nearly 30 of the students to death and severely injuring many more. Because they were along the exterior walls closing windows, the majority of the victims were boys. Four more children were caught outside when the tornado struck. Three young girls were using the school's outhouses when they were picked up and thrown nearly two-tenths of a mile across the railroad tracks. Another girl was cut in half when she was picked up by the tornado and thrown some distance into a steel lightpost. In all, 33 children were killed at the De Soto School, the greatest tornado-related death toll ever recorded at a school. After the bodies were pulled from the rubble, so many of the children's parents were injured or killed that the principal was tasked with identifying many of the students. All told, 69 people would die in De Soto.

Four miles northeast of De Soto, the community of Hurst and the mining camp at Bush experienced significant damage. Just southeast of Royalton, the Royalton-Colp Road bridge and a nearby swinging bridge were thrown from their pillars. Dozens of people were killed when about a dozen homes were damaged or destroyed in the rural areas between Royalton and Plumfield. In the small village of Plumfield, the local school was obliterated by the mile-wide tornado. Students Barbara Hamon and Anna Johnson were killed. Sarah Davis, who had been attending a meeting at the nearby church, ran to the school to comfort the children and was killed. Sarah's husband Jefferson was killed moments later when the Davis farm was demolished and he was thrown hundreds of yards into a nearby field.



At the Big Muddy River, a large section (right) of the heavy iron Royalton-Colp Road bridge was torn from its pillars and thrown into the river.

About 15 miles northeast of De Soto, the town of West Frankfort sprawled in a west-to-east direction. The Orient Mine #2, recently established on the northwest side of town, had brought an influx of population and growth. A new subdivision, complete with brand new homes and streets, sprang up to house miners and their families. As the massive vortex departed Plumfield and continued its northeastward path of destruction, the Orient Mine and its associated subdivision were squarely in its sights. On the western edge of town, two school buildings were torn from their foundations and destroyed. The newly-built homes in the area were no match for the ferocious wind, and most were obliterated. Large church buildings were also flattened, and vehicles were thrown several blocks. The home of Clyde Reed was reduced to splinters, killing a young child and injuring his wife and several other children.

The destroyed home of Clyde Reed, where his infant daughter was killed.

An aerial view from the west side of West Frankfort.

Many of West Frankfort's men were several hundred feet beneath the surface in the Orient and Caldwell mines when the tornado struck. An intense suction caused the air to rush from the mine, accompanied by a terrific roaring and shaking. One man was killed when he was caught above-ground in one of the mine buildings. When the miners emerged, they were greeted with a heartbreaking scene of abject devastation. Nearly every home in sight, most belonging to the miners and their families, was utterly decimated. In the words of one person, "everything in view was brought level to the ground." Screams of desperation issued from heaps of rubble. Those who were fortunate enough to survive without being trapped wandered the streets in a daze, most of them battered and bloody. Miners frantically clawed through the debris in search of their wives and children. Amid the remains of one home, a mother was found with her chest torn open by flying debris, her infant daughter still trying to nurse.

This aerial view, taken near the Orient Mines, is similar to the scene the miners would have witnessed upon emerging from underground.

The destruction was no less complete at the mines, where offices, manufacturing plants, equipment and other structures were completely wrecked. A mine tipple weighing several tons was pushed over and rolled some distance, and a large water tower was destroyed. A line of boxcars was thrown from the tracks just south of the mines. The nearby home of Elisha and Emma Clark, out of which the couple operated a small grocery store, was completely leveled. Elisha was blown some distance from the home and into a pile of uprooted apple trees and suffered several injuries. His wife Emma and daughter Lelia were both killed. Continuing northeastward, the tornado destroyed the Chicago & Eastern Illinois railroad roundhouse and several of the buildings at the Peabody Mine #19. Several loaded coal cars were blown from the tracks just east of Peabody #19. To the north, a bridge was blown from its piers along the C. E. I. railroad and 300 feet of track was torn from the ground. A small village of homes, stores and other buildings was destroyed to the northeast near the Peabody Mine #18, where 52 people were killed.

In total, despite only impacting the north and west sides of the town, the tornado claimed 132 lives in and around West Frankfort. More than 500 homes, three churches, two schools and numerous other buildings were demolished. Because most of the town's men worked in the mines, the majority of the fatalities were women and children. Several eyewitnesses reported that bodies from West Frankfort were later found more than a mile and a half from their original locations. According to conflicting reports, either seven or eleven members of the Karnes family were killed, including Mrs. Oscar Karnes and four of her children who were thrown into a lake near the Peabody Mine #18. Just north of Crawford Cemetery, James Kerley's home was razed to the ground and swept away. James survived, but Ettie Kerley and her children, Homer, Otto and Bertha, were killed.

James Kerley's home was swept away and his wife and four children were killed.

Just six miles to the northeast, the scene of death and destruction repeated itself in the town of Parrish. Twenty lives were lost in the small mining village as virtually every structure was leveled. Half a mile east of Parrish, the home of Randell Smith was obliterated. Randell and a relative, William Biggs, survived the tornado by clinging to a small grove of trees until the storm passed. Randell was blinded and his wife was badly injured, and their seven year old daughter Hattie was killed. Several dozen additional homes were destroyed as the tornado tore a mile-wide path toward the Hamilton County border. Trees along Ewing Creek were reportedly debarked and shredded, and several horses and a buggy near the Willow Branch School were "blown away." Between Gorham and Parrish, the tornado carved a path of devastation through 47 miles of southern Illinois. In just 40 minutes, the tornado killed at least 540 people, injured nearly 1,500 and produced $11.8 million dollars of damage — just over a billion dollars in 2000 USD.

William Biggs demonstrates how he and Randell Smith survived when they were blown from the Smith farmhouse.

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By 1925, the mining industry that defined much of southwestern Illinois had lost its grip in Hamilton and White Counties. Though a handful of small mines still dotted the pancake-flat land, farming had grown to become the driving force of the local economy. The area was rural, but hardly unpopulated. Farmhouses were scattered along nearly every road throughout both counties. The tornado thundered into Hamilton County shortly after 3:10pm, and almost immediately continued its path of destruction. Ollie Flannigan's home and barn were destroyed, killing her and her brother Sam. A photograph from the Flannigan home was later found in Bone Gap, Illinois, 50 miles to the northeast. Just to the east, Columbus Hicks and his daughter-in-law Martha were killed when the family farmhouse was swept away. Lonnie Smith's farmstead was also obliterated, killing four in the Smith family and severely injuring another. A home was destroyed to the southeast of the main path by a brief but strong satellite tornado.

In the small community of Olga, several homes were damaged or destroyed. A church was moderately damaged and the Olga School was blown off its foundation. Numerous trees were heavily damaged just southwest of town. To the northeast at the Parkers Prairie School, one student was thrown into a stand of trees and killed and Wesley Cluck, who had arrived at the school to pick up his children, was also thrown by the tornado and killed. A short distance east of the school, Chalon Cheek had gone south to a neighbor's home when they noticed billowing black clouds in the distance. Chalon watched from the neighbor's porch as the violently rotating wedge tornado bore down on his property and ripped his home from its foundation. His wife, stepdaughter and brother were in the home at the time, and all three were killed. Immediately east of the Cheek family home, the Lick Creek Bridge was lifted and thrown 300 feet into the creek. A patch of young trees and shrubs were stripped and uprooted, and grass was scoured from the ground on the Lawrence Dolan farm. At least a dozen people were killed nearby.

The remains of a destroyed home can be seen in the background of this photo near Olga.

The tornado continued an unbroken path of destruction into White County. Just southeast of the town of Enfield, the Trousdale School collapsed on the students inside and then was swept away. Reportedly all but one of the students was seriously injured. Throughout the Enfield area, dozens of homes were destroyed and swept away. Fifteen people were killed and several dozen others injured. A thick, 18-acre patch of woods near the C. S. Conger farm was almost entirely snapped and uprooted. Just to the north of the damage path there were reports of hail as large as three to four inches, occasionally so heavy that it covered the ground. Several eyewitnesses in this area described the tornado as a "rolling black mass," swirling with thousands of pieces of debris. In some cases the approach of the tornado was preceded by pieces of debris raining from the sky.

At the Newman School, several miles northwest of Carmi, teacher Jasper Mossberger noticed the skies had become dark and menacing. Sheets of rain spattered the windows, and a stiff wind rattled the door and threatened to blow it open. The students huddled around their teacher to hold the door against the approaching storm. Within moments, the roaring wind shattered the flimsy building and reduced it to rubble. Nearly every child was injured, some critically, but all survived. Teacher Jasper Mossberger initially survived, but died weeks later from complications of his injuries. Next door to the school, a mother and small child were killed when their home was destroyed and they were thrown into a ditch several hundred yards away. At this point, the tornado may have been more than 1.3 miles wide.

The Newman School was leveled by the tornado, but miraculously all the children survived.

Continuing ceaselessly to the northeast, the tornado chewed up dozens of homes, schools and churches scattered throughout central and eastern White County. Just southwest of Crossville, several cars were blown from the state road and train cars were blown off the tracks nearby. The Graves School was completely decimated and several students were thrown from the wreckage. As in Murphysboro and elsewhere, wrecked homes and their occupants occasionally faced further danger from tipped-over coal stoves that ignited the shattered piles of wood and debris. The village of Crossville itself was spared, but those immediately to the south were not so lucky. The number of deaths varies, but several homes were completely destroyed in the area. In total, 65 residents of Hamilton and White counties were killed, including more than 30 farm owners. The exceptional intensity, forward speed and unusually large and occasionally obscured appearance conspired to catch even the most weather-

wise farmers off-guard. The monstrous vortex had already done the worst of its terrible work, but still more was to come upon crossing the Wabash River into Indiana.

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Just before 4:00pm, the twister raced across the Wabash River, destroying homes on both banks, and bore down on the little village of Griffin. Measuring only half a mile north to south, Griffin was no match for the massive, mile-wide tempest. A number of farm homes just south and west of town were immediately swept clean. At Bethel Township School, the school's only bus had left to deliver half the children on the west part of town before circling back to pick up the others. As the bus made its first stop to drop off the Vanway children — Harry, Ellen, Hellen and Evelyn — bus driver Chick Oller noticed objects of various sizes falling from the sky. Within seconds the massive funnel barreled across Matz Road, tossing and tumbling the bus and tearing at the sheet metal exterior. When the bus came to rest in a nearby field, the mangled frame rested atop two children who had been crushed beneath it. Harry and Hellen Vanway were caught in the violent storm of debris just outside their home. Harry was struck in the head by a flying timber and killed instantly, while Hellen was gravely injured and died within hours.

In Griffin proper, the destruction was complete. As in Gorham, 100 percent of the structures in town were damaged or destroyed, most of them leveled. Eyewitnesses described a very large, multivortex tornado that produced several funnels that "moved around and then came together." Several stores, a gas station, a theater, an electric light plant and several churches were also destroyed. The large brick Bethel Township School was heavily damaged but not destroyed. Many of the structures that escaped heavy damage from the initial strike of the tornado were destroyed when one subvortex reportedly wrapped around the southwest flank and raked the eastern and central portions of the town. Dark, fine silt and mud, picked up from the Wabash River as the tornado crossed it, was plastered to both people and homes. Several poles were snapped just above ground level, and the railroad tracks were once again pulled from the ground and bent at odd angles. In the few seconds it took the tornado to plow through the three-block width of Griffin, a full 60% of its 400 citizens were counted among the casualties, including dozens of fatalities.

The rubble of the business district, including Trinity Baptist Church. Only the steps (left center) remain standing. A relief train can be seen in the background.

After devastating Griffin, the tornado continued on across northern Posey and southwestern Gibson counties, destroying rural homes in much the same way as it had done in Hamilton and White counties earlier. It clipped the northwest edge of Owensville, destroying the Christian Church and several homes. At one home, William King and his son Walter were killed, as were their wives Elizabeth and Lora. Many trees were stripped and mangled at an apple orchard just north of Owensville. A forest nearby also suffered heavy damage. Dozens of other homes and barns were damaged or destroyed across central Gibson County as the tornado continued at a width of nearly one mile. Several vehicles were thrown or rolled great distances from the road, and a locomotive and its railcars were pushed from the tracks just outside of town. Vegetation may also have been scoured from the ground in nearby rural areas.

Part of a Ford Model T that was thrown from the road and destroyed.

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It was 4:18pm — a full three hours after the great storm had first begun its path of apocalyptic destruction — and yet the tornado had lost none of its power when it emerged on the horizon west of Princeton, Indiana. With a population of just over 6,000 in 1925, Princeton was famed for its excellent tomato farms. The H. J. Heinz Company quickly became one of the area's largest employers, using local tomatoes to produce its ketchup and other products in a pair of large brick buildings on the south side of town. Like so many other towns in Indiana and Illinois, Princeton also benefitted greatly from the rich coal seams atop which it sat.

On the afternoon of March 18, downtown Princeton was buzzing with activity. Like any other Wednesday, it was "Bargain Day," when people from all around came to shop at the many stores that offered sales and raffles. At about 4:00pm, small bits of debris began to drift down from the sky like snowflakes. The western sky became bruised and menacing, the black clouds flickering with constant lightning. When the swirling funnel came into view, it was choked with debris. It had already wiped dozens of homes from the earth on its way from Owensville to Princeton, and it made quick work of the nursery building and a grove of mature fruit trees on the southwest edge of town. Many homes in the nearby McKaw Summit subdivision suffered damage from the northern edge of the tornado.

Severe Weather Awareness

Two men pick through the rubble of a home in McKaw subdivision.

In the Baldwin Heights subdivision, immediately west of the Heinz Company's factories, the destruction was complete. More than two dozen homes were razed to the ground. The sturdy, well-built Heinz factory and office buildings were damaged considerably but not destroyed. The storage building was swept away. Heavy iron support structures were damaged and bent at the Southern Railroad Shop, where the roundhouse and several other structures suffered major damage. Continuing through the primarily residential southern section of Princeton, the tornado left a streak of complete destruction about a quarter of a mile wide and a broader area of substantial damage just over a mile wide. Though most of downtown was spared, the destruction was massive. Much of the southern third of the town was reduced to rubble, and 45 people were killed.

At approximately 4:29pm, more than 220 miles after it began, the Great Tri-State Tornado shrunk, weakened and finally dissipated over an unplanted corn field on the Silas Merrick property, ten miles northeast of Princeton. In its wake, nearly a dozen cities and towns were left broken. Two were utterly wiped from the surface of the earth. At least 695 people were killed, over 2,000 injured, and many tens of thousands left homeless. It maintained a forward speed of well over 60 mph over three and a half hours, at times reaching a width in excess of 1.25 miles, and claimed both rural farmers and urbanites alike. The single greatest tornado event in world history left a toll, both in lives and in damages, that was nearly beyond comprehension. And yet, the day was not done. Great thunderheads were building across the Heartland and parts of the Southeast.

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About 15 minutes later and 250 miles away, a small tornado cut an extremely narrow path through Colbert County in Alabama. The tornado damaged a gas station, two homes and a shop near Littleville, killing one man and injuring about a dozen. Just after 5:00pm, an imposing storm that had been brewing over western Tennessee dropped a small, ragged funnel near the community of Buck Lodge in central Sumner County. The tornado rapidly grew to nearly a quarter mile in width and the tornado claimed its first lives when Matilda and Maude Key were killed in their home. Continuing on, the tornado passed near the community of Graball.

Just to the northeast, the homes of Jim and Mary Allison and the Henry Hughes and Cleveland Hughes families sat atop a small hill. Ella Hughes, being home alone when the storm approached, became frightened when she heard a dull roar to the west-southwest. She sprinted off in the pounding rain and wind toward the Allison home a half-mile away. Moments later, as the Allison family prepared for their dinner, the violent tornado barreled over the hill and obliterated their home. Jim and Mary Allison and all six of their children, ages 20, 16, 14, 6, 5 and 4, were killed instantly. The tornado struck with such unbridled fury that the bodies were scattered over a quarter of a mile, mangled and wrapped around debarked tree stubs. The two youngest children were "torn in sections," and surviving relatives were unable to identify many of the remains. Ella Hughes, who had just reached the house as the storm bore down, was also killed. Tragically, her home was left almost entirely unscathed.

Three men survey the wreckage of the Allison home, where nine people were killed.

A short distance to the northeast, the home of Ella's father-in-law Henry was swept cleanly away. Henry, his son-in-law Cleveland and his wife were killed when the home was destroyed. In a community called Angle, just south of Oak

Grove, the tornado again demonstrated its frightful power. The homes of Charles Durham and his son Joe were completely leveled and swept away. Charles, his wife and their baby daughter Lorena were killed. Moments later, Joe Durham's wife and two children were killed. Joe was away at the time and was the only member of his family to survive. Several yards away, Charles Holmes' home was also swept cleanly from its foundation. Charles and his wife were both killed, but their two daughters survived despite serious injuries. A contemporary report from The Knoxville Journal recorded that even concrete and stone foundations were scoured from the ground and scattered by the savage wind at several locations between Keytown and Oak Grove, but there is no known photographic evidence of this.

The tornado continued its campaign of ruin in the little village of Liberty. According to one eyewitness who watched the event from a distant hill, the Liberty Presbyterian Church was torn from its foundation whole before quickly disintegrating "like a bunch of matchsticks." A home just down the road from the church was also obliterated, but the family survived by taking shelter in a milk well. The Brown home was swept clean just to the northeast, and the entire family was killed. Wheat and grass were scoured from the ground in a field across the road, leaving nothing but a 60-yard wide, 200 yard long streak of dirt. After destroying a string of homes for several more miles, the tornado may have weakened or lifted briefly in Macon County. As it neared the Kentucky state line, however, tornado damage again became intense. The tornado destroyed several dozen homes and killed four people in the community of Holland, and killed another eight people in Beaumont before coming to an end after about 60 miles on the ground.

Severe Weather Awareness

In central Harrison County, Indiana, yet another monster tornado dropped to the earth at about 5:15pm. After causing extensive tree damage in a narrow path, the tornado rapidly expanded to nearly a mile wide. Several farmhouses were swept cleanly away near Laconia, where two people in one family were killed. Near Elizabeth, two more people were killed when about a dozen homes were flattened and swept away. The tornado weakened and narrowed as it crossed the state line south of Louisville. At least four other tornadoes raked Tennessee and Kentucky in the next hour and a half, including one tornado that destroyed a number of homes and completely scoured the ground.

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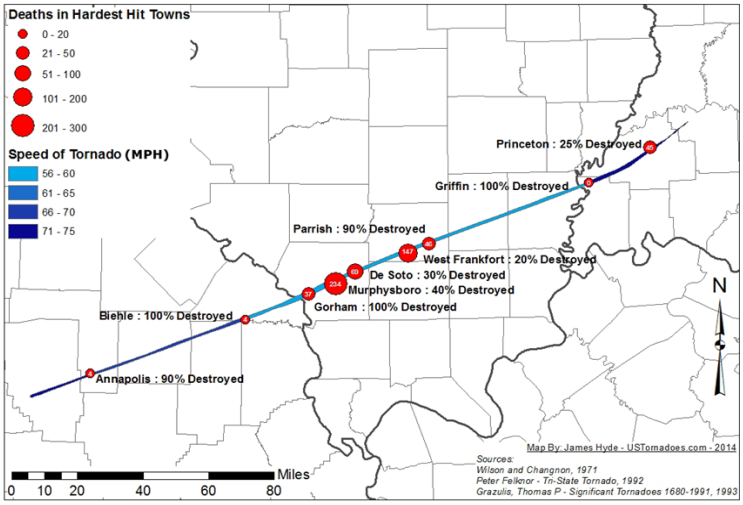
By the time the sun had set on Wednesday, March 18, 1925, at least 747 people laid dead across five states and more than 425 miles of ruin. With at least 695 fatalities, the Tri-State Tornado alone claimed a staggering 142 more lives than the next-deadliest entire year on record (553 in 2011). The tornado caused the most student fatalities in a single tornado (69) and the most deaths ever at one school (33) in De Soto. The tornado also has the record for the longest path ever recorded, though the exact length is uncertain. Beginning from the first recorded tornado damage in Shannon County, Mo. and ending with the last recorded damage northeast of Princeton, Ind., the total length is approximately 235 miles, with several gaps in damage reports that could indicate breaks in the path. There are mostly continuous damage reports from south of Fredricktown in Madison County, Mo. to the end of the accepted path about ten miles northeast of Princeton in far western Pike County, Ind. This suggests a path length of at least 174 miles, still the longest confirmable path length ever recorded.

The Great Tri-State Tornado remains an historical anomaly of terrifying proportions. Never before or since have we seen a tornado in the United States kill so many people, stay on the ground so long,

travel so quickly or cause so much damage. Understandably overshadowed by the great tragedy to the north, the outbreak across Kentucky and Tennessee may well have been very significant in itself. The overwhelming devastation across the areas affected left marks that took decades to heal. Tens of thousands of people left homeless, many of them also rendered jobless, just years before the Great Depression closed its grip on the nation. Even in light of devastating tornadoes and outbreaks in recent years it's difficult to make sense of the incredible scale of destruction. The full details of that day are likely lost to the march of time, but March 18, 1925 undoubtedly remains one of the greatest natural disasters in American history.

Tri-State Tornado - March 18, 1925

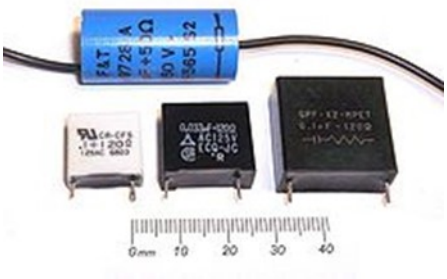


The Experimenter's Bench

Snubbers

Snubbers are frequently used in electrical systems with an inductive load where the sudden interruption of current flow often leads to a sharp rise in voltage across the device creating the interruption. This sharp rise in voltage is a transient and can damage and lead to failure of the controlling device. A spark is likely to be generated (arcing), which can cause electromagnetic interference in other circuits. The snubber prevents this undesired voltage by conducting transient current around the device.

RC snubbers



A simple snubber uses a small resistor (R) in **series** with a small capacitor (C). This combination can be used to suppress the rapid rise in voltage across a thyristor, preventing the erroneous turn-on of the thyristor; it does this by limiting the rate of rise in voltage (dV/dt) across the thyristor to a value which will not trigger it. Snubbers are also often used to prevent arcing across the contacts of relays and switches and the electrical interference and welding/sticking of the contacts that can occur. An appropriately-designed RC snubber can be used with either DC or AC loads. This sort of snubber is commonly used with inductive loads such as electric motors.

The voltage across a capacitor cannot change instantaneously, so a decreasing transient current will flow through it for a small fraction of a second, allowing the voltage across the switch to increase more slowly when the switch is opened. While the values can be optimized for the application, a 100 ohm non-inductive resistor in series with a 100 nanofarad, or larger, capacitor of appropriate voltage rating is usually effective. Determination of voltage rating can be difficult owing to the nature of transient waveforms; the actual rating can be determined only by measuring temperature rise of the capacitor. This type of snubber is often manufactured as a single component.

Diode snubbers

When the current flowing is DC, a simple rectifier diode is often employed as another form of snubber. The snubber diode is wired in parallel with an inductive load (such as a relay coil or electric motor). The diode is installed so that it does not conduct under normal conditions. When

current to the inductive load is rapidly interrupted, a large voltage spike would be produced in the reverse direction (as the inductor attempts to keep current flowing in the circuit). This spike is known as an "inductive kick". Placing the snubber diode in inverse parallel with the inductive load allows the current from the inductor to flow through the diode rather than through the switching element, dissipating the energy stored in the inductive load over the series resistance of the inductor and the (usually much smaller) resistance of the diode (over-voltage protection). One disadvantage of simple rectifier diode used as a snubber is that the diode allows current to continue flowing, which may cause the relay to remain actuated for slightly longer; some circuit designs must account for this delay in the *dropping-out* of the relay. This delay often leads to greatly decreased life of the relay contacts due to arcing.

More-sophisticated solid-state snubbers

In some DC circuits, a varistor or two inverse-series Zener diodes (collectively called a transorb) may be used instead of the simple diode. Because these devices dissipate significant power, the relay may drop-out faster than it would with a simple rectifier diode. An advantage to using a transorb over just one diode however, is that it will protect against over voltage with both polarities if connected to ground, forcing the voltage to stay between the confines of the breakdown voltages of the Zener diodes. A Zener diode connected to ground will protect against positive transients to the value of the Zener breakdown, and will protect against negative transients greater than a normal forward diode drop.

In AC circuits a rectifier diode snubber cannot be used; if a simple RC snubber is not adequate a more complex bidirectional snubber design must be used.

Multipath Propagation

Multipath propagation and fading tutorial includes:

- Multipath propagation basics
- Multipath fading
- Rayleigh fading

Multipath propagation is a fact of life in any terrestrial radio scenario. While the direct or line of sight path is normally the main wanted signal, a radio receiver will receive many signals resulting from the signal taking a large number of different paths. These paths may be the result of reflections from buildings, mountains or other reflective surfaces including water, etc. that may be adjacent to the main path. Additionally other effects such as ionospheric reflections give rise to multipath propagation as does tropospheric ducting.

The multipath propagation resulting from the variety of signal paths that may exist between the transmitter and receiver can give rise to interference in a variety of ways including distortion of the signal, loss of data and multipath fading.

At other times, the variety of signal paths arising from the multipath propagation can be used to advantage. Schemes such as MIMO use multipath propagation to increase the capacity of the channels they use. With increasing requirements for spectrum efficiency, the use of multipath propagation for technologies such as MIMO are able to provide significant improvements in channel capacity that are much needed.

Multipath propagation basics

Multipath radio signal propagation occurs on all terrestrial radio links. The radio signals not only travel by the direct line of sight path, but as the transmitted signal does not leave the transmitting antenna in only the direction of the receiver, but over a range of angles even when a directive antenna is used. As a result, the transmitted signals spread out from the transmitter and they will reach other objects: hills, buildings reflective surfaces such as the ground, water, etc. The signals may reflect of a variety of surfaces and reach the receiving antenna via paths other than the direct line of sight path.

Multipath fading

Signals are received in a terrestrial environment, i.e. where reflections are present and signals arrive at the receiver from the transmitter via a variety of paths. The overall signal received is the sum of all the signals appearing at the antenna. Sometimes these will be in phase with the main signal and will add to it, increasing its strength. At other times they will interfere with each other. This will result in the overall signal strength being reduced.

At times there will be changes in the relative path lengths. This could result from either the transmitter or receiver moving, or any of the objects that provides a reflective surface moving. This will result in the phases of the signals arriving at the receiver changing, and in turn this will result in the signal strength varying. It is this that causes the fading that is present on many signals.

It can also be found that the interference may be flat, i.e. applied to all frequencies equally across a given channel, or it may be selective, i.e. applying to more to some frequencies across a channel than others. A more in depth description of multipath fading is given in a page referenced in the "Related Articles" section on the left hand side of this page below the main menu.

Interference caused by multipath propagation

Multipath propagation can give rise to interference that can reduce the signal to noise ratio and reduce bit error rates for digital signals. One cause of a degradation of the signal quality is the multipath fading already described. However there are other ways in which multipath propagation can degrade the signal and affect its integrity.

One of the ways which is particularly obvious when driving in a car and listening to an FM radio. At certain points the signal will become distorted and appear to break up. This arises from the fact that the signal is frequency modulated and at any given time, the frequency of the received signal provides the instantaneous voltage for the audio output. If multipath propagation occurs, then two or more signals will appear at the receiver. One is the direct or line of sight signal, and another is a reflected signal. As these will arrive at different times because of the different path lengths, they will have different frequencies, caused by the fact that the two signals have been transmitted by the transmitter at slightly different times. Accordingly when the two signals are received together, distortion can arise if they have similar signal strength levels.

Another form of multipath propagation interference that arises when digital transmissions are used is known as Inter Symbol Interference, ISI. This arises when the delay caused by the extended path length of the reflected signal. If the delay is significant proportion of a symbol, then the receiver may receive the direct signal which indicates one part of the symbol or one state, and another signal which is indicating another logical state. If this occurs, then the data can be corrupted.

How intersymbol interference can be avoided

One way of overcoming this is to transmit the data at a rate the signal is sampled, only when all the reflections have arrived and the data is stable. This naturally limits the rate at which data can be transmitted, but ensures that data is not corrupted and the bit error rate is minimized. To calculate this the delay time needs to be calculated using estimates of the maximum delays that are likely to be encountered from reflections.

Using the latest signal processing techniques, a variety of methods can be used to overcome the problems with multipath propagation and the possibilities of interference.

OFDM and multipath propagation

In order to meet the requirements to transmit large amounts of data over a radio channel, it is necessary to choose the most appropriate form of signal bearer format. One form of signal lends itself to radio data transmissions in an environment where reflections may be present is Orthogonal Frequency Division Multiplex, OFDM. An OFDM signal comprises a large number of carriers, each of which are modulated with a low bit rate data stream. In this way the two contracting requirements for high data rate transmission, to meet the capacity requirements, and low bit rate to meet the intersymbol interference requirements can be met.

Note on OFDM:

Orthogonal Frequency Division Multiplex (OFDM) is a form of transmission that uses a large number of close spaced carriers that are modulated with low rate data. Normally these signals would be expected to interfere with each other, but by making the signals orthogonal to each another there is no mutual interference. This is achieved by having the carrier spacing equal to the reciprocal of the symbol period. This means that when the signals are demodulated they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution. The data to be transmitted is split across all the carriers and this means that by using error correction techniques, if some of the carriers are lost due to multi-path effects, then the data can be reconstructed. Additionally having data carried at a low rate across all the carriers means that the effects of reflections and inter-symbol interference can be overcome. It also means that single frequency networks, where all transmitters can transmit on the same channel can be implemented.

OFDM is the modulation format that is used for many of today's data transmission formats. The applications include 802.11n Wi-Fi, LTE (Long Term Evolution for 3G cellular telecommunications), LTE Advanced (4G), WiMAX and many more. The fact that OFDM is being widely used demonstrates that it is an ideal format to overcome multipath propagation problems.

MIMO

While multipath propagation creates interference for many radio communications systems, it can also be used to advantage to provide additional capacity on a given channel. Using a scheme known as MIMO, multiple input multiple output, it is possible to multiple the data capacity of a given channel several times by using the multipath propagation that exists.

Note on MIMO:

Two major limitations in communications channels can be multipath interference, and the data throughput limitations as a result of Shannon's Law. MIMO provides a way of utilising the multiple signal paths that exist between a transmitter and receiver to significantly improve the data throughput available on a given channel with its defined bandwidth. By using multiple antennas at the transmitter and receiver along with some complex digital signal processing, MIMO technology enables the system to set up multiple data streams on the same channel, thereby increasing the data capacity of a channel.

In view of the advantages that MIMO offers, many current wireless and radio communications schemes are using it to make far more efficient use of the available spectrum. The disadvantage to MIMO is that it requires the use of multiple antennas, and with modern portable equipment such as cell phones being increasingly small, it can be difficult to place tow sufficiently spaced antennas onto them.

Multipath propagation is an issue for any radio communications system. Ranging from the short range wireless communications such as Wi-Fi though the cellular and longer range data schemes such as WiMAX though to VHF links where tropospheric propagation may affect the signal path, through to HF systems using the ionosphere for reflections. In all of these systems, the effects of multipath propagation can be seen and experienced. Any form of communications, therefore has to be able to accommodate the effects of the multipath propagation in one way or another.
Multipath Fading

- summary, tutorial or overview about the essentials multipath fading, a phenomenon that is present on many radio signals, cellular, HF and VHF.

Multipath propagation and fading tutorial includes:

- Multipath propagation basics
- Multipath fading
- Rayleigh fading

Multipath fading affects most forms of radio communications links in one form or another. Multipath fading can be detected on many signals across the frequency spectrum from the HF bands right up to microwaves and beyond. It is experienced not only by short wave radio communications where signals fade in and out over a period of time, but it is also experienced by many other forms of radio communications systems including cellular telecommunications and many other users of the VHF and UHF spectrum.

Multipath fading occurs in any environment where there is multipath propagation and there is some movement of elements within the radio communications system. This may include the radio transmitter or receiver position, or in the elements that give rise to the reflections. The multipath fading can often be relatively deep, i.e. the signals fade completely away, whereas at other times the fading may not cause the signal to fall below a useable strength.

Multipath fading may also cause distortion to the radio signal. As the various paths that can be taken by the signals vary in length, the signal transmitted at a particular instance will arrive at the receiver over a spread of times. This can cause problems with phase distortion and intersymbol interference when data transmissions are made. As a result, it may be necessary to incorporate features within the radio communications system that enables the effects of these problems to be minimized.

Multipath fading basics

Multipath fading is a feature that needs to be taken into account when designing or developing a radio communications system. In any terrestrial radio communications system, the signal will reach the receiver not only via the direct path, but also as a result of reflections from objects such as buildings, hills, ground, water, etc that are adjacent to the main path.

The overall signal at the radio receiver is a summation of the variety of signals being received. As they all have different path lengths, the signals will add and subtract from the total dependent upon their relative phases.

At times there will be changes in the relative path lengths. This could result from either the radio transmitter or receiver moving, or any of the objects that provides a reflective surface moving. This will result in the phases of the signals arriving at the receiver changing, and in turn this will result in the signal strength varying as a result of the different way in which the signals will sum together. It is this that causes the fading that is present on many signals.

Selective and flat fading

Multipath fading can affect radio communications channels in two main ways. This can given the way in which the effects of the multipath fading are mitigated.

Flat fading: This form of multipath fading affects all the frequencies across a given channel either equally or almost equally. When flat multipath fading is experienced, the signal will just change in amplitude, rising and falling over a period of time, or with movement from one position to another.

Selective fading: Selective fading occurs when the multipath fading affects different frequencies across the channel to different degrees. It will mean that the phases and amplitudes of the signal will vary across the channel. Sometimes relatively deep nulls may be experienced, and this can give rise to some reception problems. Simply maintaining the overall amplitude of the received signal will not overcome the effects of selective fading, and some form of equalization may be needed. Some digital signal formats, e.g. OFDM are able to spread the data over a wide channel so that only a portion of the data is lost by any nulls. This can be reconstituted using forward error correction techniques and in this way it can mitigate the effects of selective multipath fading.

Selective multipath fading occurs because even though the path length will be change by the same physical length (e.g. the same number of meters, yards, miles, etc.) this represents a different proportion of a wavelength. Accordingly the phase will change across the bandwidth used.

Selective fading can occur over many frequencies. It can often be noticed when medium wave broadcast stations are received in the evening via ground wave and skywave. The phases of the signals received via the two means of propagation change with time and this causes the overall received signal to change. As the multipath fading is very dependent on path length, it is found that it affects the frequencies over even the bandwidth of an AM broadcast signal to be affected differently and distortion results.

Selective multipath fading is also experienced at higher frequencies, and with high data rate signals becoming commonplace wider bandwidths are needed. As a result nulls and peaks may occur across the bandwidth of a single signal.

Cellular multipath fading

Cellular telecommunications is subject to multipath fading. There are a variety of reasons for this. The first is that the mobile station or user is likely to be moving, and as a result the path lengths of all the signals being received are changing. The second is that many objects around may also be moving. Automobiles and even people will cause reflections that will have a significant effect on the received signal. Accordingly multipath fading has a major bearing on cellular telecommunications.

Often the multipath fading that affects cellular phones is known as fast fading because it occurs over a relatively short distance. Slow fading occurs as a cell phone moves behind an obstruction and the signal slowly fades out.

The fast signal variations caused by multipath fading can be detected even over a short distance. Assume a frequency of 2 GHz (e.g. a typical approximate frequency value for many 3G phones). The wavelength can be calculated as:

$$\lambda = c / f$$
$$= 3 \times 108 / 2 \times 109$$
$$= 0.15 \text{ metres}$$

Where:
c = speed of light in metres per second
f = frequency in Hertz

To move from a signal being in phase to a signal being out of phase is equivalent to increasing the path length by half a wavelength or 0.075m, or 7.5 cms. This example looks at a very simplified example. In reality the situation is far more complicated with signals being received via many paths. However it does give an indication of the distances involved to change from an in-phase to an out of phase situation.

Ionospheric multipath fading

Short wave radio communications is renowned for its fading. Signals that are reflected via the ionosphere, vary considerably in signal strength. These variations in strength are primarily caused by multipath fading.

When signals are propagated via the ionosphere it is possible for the energy to be propagated from the transmitter to the receiver via very many different paths. Simple diagrams show a single ray or path that the signal takes. In reality the profile of the electron density of the ionosphere (it is the electron density profile that causes the signals to be refracted) is not smooth and as a result any signals entering the ionosphere will be scattered and will take a variety of paths to reach a particular receiver. With changes in the ionosphere causing the path lengths to change, this will result in the phases changing and the overall summation at the receiver changing. [See the pages on ionospheric propagation within the Radio Wave Propagation section of this website for further details of this form of propagation].

The changes in the ionosphere arise from a number of factors. One is that the levels of ionization vary, although these changes normally occur relatively slowly, but nevertheless have an effect. In addition to this there are winds or air

movements in the ionosphere. As the levels of ionization are not constant, any air movement will cause changes in the profile of the electron density in the ionosphere. In turn this will affect the path lengths.

Tropospheric multipath fading

Many signals using frequencies at VHF and above are affected by the troposphere. The signal is refracted as a result of the changes in refractive index occurring, especially within the first kilometers above the ground. This can cause signals to travel beyond the line of sight. In fact for broadcast applications a figure of 4/3 of the visual line of sight is used for the radio horizon. However under some circumstances relatively abrupt changes in refractive index occurring as a result of weather conditions can cause the distances over which signals travel to be increased. Signals may then be "ducted" by the ionosphere over distances up to a few hundred kilometers. [See the pages on tropospheric propagation within the Radio Wave Propagation section of this website for further details of this form of propagation].

When signals are ducted in this way, they will be subject to multipath fading. Here, heat rising from the Earth's surface will ensure that the path is always changing and signals will vary in strength. Typically these changes may be relatively slow with signals falling and rising in strength over a period of a number of minutes.

Multipath fading is a feature of many radio communications links. Multipath fading occurs as a result of the many signal paths that are in existence on all terrestrial radio communications links whether they are used for applications such as cellular telecommunications, mobile radio, or for HF or VHF radio communications. As such it is necessary to account for multipath fading in the design of many radio communications systems.

Rayleigh Fading
- summary, tutorial or overview about the essentials of Rayleigh fading and how it applies to radio signal paths where multiple reflections and paths are available.

Multipath propagation and fading tutorial includes:

- Multipath propagation basics
- Multipath fading
- Rayleigh fading

Rayleigh fading is the name given to the form of fading that is often experienced in an environment where there is a large number of reflections present. The Rayleigh fading model uses a statistical approach to analyze the propagation, and can be used in a number of environments.

The Rayleigh fading model is normally viewed as a suitable approach to take when analyzing and prediction radio wave propagation performance for areas such as cellular communications in a well built up urban environment where there are many reflections from buildings, etc.. HF ionospheric radio wave propagation where reflections (or more exactly refractions) occur at many points within the ionosphere is also another area where Rayleigh fading model applies well. It is also appropriate to use the Rayleigh fading model for tropospheric radio propagation because, again there are many reflection points and the signal may follow a variety of different paths.

The Rayleigh propagation model is most applicable to instances where there are many different signal paths, none of which is dominant. In this way all the signal paths will vary and can have an impact on the overall signal at the receiver.

Rayleigh fading basics

The Rayleigh fading model is particularly useful in scenarios where the signal may be considered to be scattered between the transmitter and receiver. In this form of scenario there is no single signal path that dominates and a statistical approach is required to the analysis of the overall nature of the radio communications channel.

Rayleigh fading is a model that can be used to describe the form of fading that occurs when multipath propagation exists. In any terrestrial environment a radio signal will travel via a number of different paths from the transmitter to the receiver. The most obvious path is the direct, or line of sight path.

However there will be very many objects around the direct path. These objects may serve to reflect, refract, etc the signal. As a result of this, there are many other paths by which the signal may reach the receiver.

When the signals reach the receiver, the overall signal is a combination of all the signals that have reached the receiver via the multitude of different paths that are available. These signals will all sum together, the phase of the signal being important. Dependent upon the way in which these signals sum together, the signal will vary in strength. If they were all in phase with each other they would all add together. However this is not normally the case, as some will be in phase and others out of phase, depending upon the various path lengths, and therefore some will tend to add to the overall signal, whereas others will subtract.

As there is often movement of the transmitter or the receiver this can cause the path lengths to change and accordingly the signal level will vary. Additionally if any of the objects being used for reflection or refraction of any part of the signal moves, then this too will cause variation. This occurs because some of the path lengths will change and in turn this will mean their relative phases will change, giving rise to a change in the summation of all the received signals.

The Rayleigh fading model can be used to analyze radio signal propagation on a statistical basis. It operates best under conditions when there is no dominant signal (e.g. direct line of sight signal), and in many instances cellular telephones being used in a dense urban environment fall into this category. Other examples where no dominant path generally exists are for ionospheric propagation where the signal reaches the receiver via a huge number of individual paths. Propagation using tropospheric ducting also exhibits the same patterns. Accordingly all these examples are ideal for the use of the Rayleigh fading or propagation model.

Never On Sunday

John Meyer

Target: E-4.
Command and Control: MACV-SOG.
Area of Operations: Laos.
Codename: Prairie Fire
Mission: Primary--General recon.
Secondary--Find major NVA POW underground complex where U.S. POWs are held. Complex located near major intersection of Ho Chi Minh Trail in Laos.
Alternate--Cancel mission if opportunity to capture live NVA soldier arises.
Target Team: Spike Team (ST) Idaho.
Date: 6 October 1968
Launch site: Phu Bai, FOB #1, South Vietnam
Insertion Aircraft: Vietnamese-piloted Sikorsky H-34 helicopters. Kingbees.
Lead Ship: 10-U.S. team leader, 11-U.S. assistant team leader and 01-Vietnamese team leader.
Second Ship: 12-3rd American, 02-team interpreter and 03-point man, Vietnamese team.
Third Ship: Backup.
Assets on site: two A1E Skyraiders, one 0-2 covey, two UH-1B Huey gunships and Phantom F- 4s on call.

I always though Sunday was a good day not to run missions, especially when the target area was in the deadly Prairie Fire AO (area of operation). However, for several days prior to 6 October 1968, the weather had been cloudy and uncertain, which prevented any Forward Operating Base (FOB)-1 teams in Phu Bai from launching into Laos AO. FOB-1 sat along Highway 1, north of Phu Bai airport, on the north side of an ARVN training compound, just south of the tiny village of Phu Luong, about 10 miles south of Hue.

When there were no teams on the ground, the brass in Saigon got nervous. Hence, in the mornings the first thing the team leaders did was to check the mountains west of Phu Bai. If they were clear, the brass would try to get a team or a Hatchet Force inserted in Prairie Fire.

On Saturday, 5 October 1968, the weather had broken enough for ST Idaho One Zero (U.S. team leader) Staff Sergeant Donald W "Don" Wolken to fly over a VR (visual reconnaissance) over the target area. Wile Wolken was flying, Sau (the Vietnamese team leader) and I inspected the team.

Sunday morning, the weather was crystal clear, nary a cloud in the sky. Wolken and Sau quickly inspected the team: each American carried a minimum of 25 magazines for their CAR-15s, the Vietnamese carried 20 magazines. Wolken and I both carried sawed-off M-79s, 21 HE rounds and one tear gas round. Wolken also carried a .22-caliber semiautomatic pistol with a suppressor. I carried the PRC-25 radio and a bunch of hand grenades, while Robinson and the Vietnamese carried several claymore mines and extra batteries for the PRC-25. Sau and all Americans carried URC-10 emergency radio also.

Shortly before we left, the team posed for a photograph, over the strong protests of Sau and our interpreter Hiep. They said we'd jinx the mission.

A few minutes later, we were on the H-34s flying west on the hour-plus flight to Laos. Those long flights to the target area were peaceful and memorable because we were flying high, where the air was cooler, looking at the dark, lush greens of the jungle. From 4,000 feet, South Vietnam, Laos and Cambodia were beautiful. During these flights, I often thought about my grandfather's farm in Belle Mead, New Jersey.

As the H-34s churned westward, my vision always seemed better, aided by the adrenaline that was flowing, anticipating the unknown. Once over Laos, the door gunners test-fired their .30- caliber machine guns.

Then, the Kingbees went into a dying swan spiral, spinning madly toward the earth. The G-force pushed my stomach upward into my chest. At the last second, the pilot flared out and hovered a few feet off the ground. The right wheel of the Kingbee touched the bomb crater that was our LZ. While we were descending, Wolken sat in the door, looking at the LZ itself. I squatted behind him, with my hand on his left shoulder, watching the perimeter of the LZ for any enemy movement.

Now the blood was pounding through our veins. As the Kingbee wheel again touched the lip of the bomb crater, Wolken jumped out and promptly disappeared in the elephant grass. I followed. When I landed on the crater, I started slipping down the outside lip. The angle alongside the hill was much steeper than I had realized and the ground was muddy and slippery. I started rolling down the hill, the same way Wolker had. Robinson and the Vietnamese successfully landed on the crater's lip and laughed at Wolken and me. It took us several minutes to rejoin the team.

I radioed Sergeant First Class Robert "Spider" Parks, who was flying overhead in the 0-2 Covey, and told him that we were OK. Spider said he'd stand by for 10 more minutes before releasing the assets. Ten minutes later I broke squelch three times for the final team OK. As we moved away from the LZ, Phouc was walking point, with Sau behind him. Wolken was third in line. I was behind him, Robinson was behind me while Hiep brought up the rear. We took a break as Phouc, Sau and Wolken applied mud to their bee stings.

About half an hour later, Phouc signaled that he heard a lot of activity in front of him. Within seconds we all heard the noise. At first, we thought it was an NVA regiment charging toward us. I got behind a log and pulled a pin from an M26 frag grenade, only to realize that we were being overrun by a chattering group of monkeys.

After being overrun, we went into the standard move-10 minutes, wait-10 minutes pace, on the principle that in the jungle you can learn more from hearing than seeing. Then around noon, we heard the first shot fired by an enemy tracker. By 1400 hours they sounded like they had located our trail. By dusk, the trackers had moved through the thick jungle quicker than we had and were closing in on us. We kept moving until last light, then we finally set up our RON (Rest [Remain] Over Night) site. As I moved out to place a claymore mine on our eastern perimeter, the tracker startled us b firing one last round, which sounded like he was less than 10 meters from our southern perimeter.

Because the trackers were so close, we didn't eat until midnight, after I radioed a team OK to the airborne command center that flew over Southeast Asia 24 hours a day. Sau and Hiep went right to sleep. Between 2000 hours and 0200 hours the next morning, I listened to the tracker skirt our team, ending his travel in front of my claymore mine.

I wasn't sure if he had located it or not, so I detonated it and woke up the team and half the jungle with the explosive roar. For the rest of the night, there was no more movement around our perimeter.

At first light, we moved on. When Spider flew over, I gave him a quick sitrep (situation report). Through the morning, we heard no more tracker shots or any obvious enemy movement. The only thing that concerned me was the fact that Sau's eyes began to get bigger as the day progressed. By that time, he had been running missions for five years. He could smell the NVA. During one break, he said, "Beaucoup VC, beaucoup VC." That scared me, because I hadn't heard or seen anything to corroborate Sau's intuition.

At noontime, I gave Spider a team OK, but told him Sau was nervous. Spider reminded me to trust Sau's instincts and said he'd return at 1600 hours. By now, Sau and Hiep had swapped places, with Sau in the rear and me in the number five slot next to him. Around 1300 hours, I heard Sau hiss like a snake. Across a ravine, on the hill we had just descended, were two NVA soldiers, armed with AK-47s and smiles.

Smiles!!

What kind of game was this?! They didn't raise their weapons or make any hostile moves. They just smiled at us. Because they were no more than 45 yards away, I pulled out my sawed-off M79, indicating to Sau I'd like to permanently wipe the smiles off those smirking faces. Sau said, "no, beaucoup VC, di, di! (go, go)."

I told Wolken what happened and immediately we headed by high ground. Within an hour, we were atop a knoll big enough to hold ST Idaho. Wolken told me to get the PRC-25 and get Spider back over us ASAP.
By now, Sau's eyes were bigger than saucers. I put the long antenna on the PRC-25 and made several calls on the primary, secondary and alternate frequencies, to no avail. I turned on the emergency beeper on the URC-10. That distress signal was on a channel which was supposed to be monitored at all times by all aircraft flying over the Prairie Fire AO.

No one responded. I opened a can of apricots and was sipping the sweet nectar when all hell broke loose.
Suddenly, the green jungle around us erupted with deafening full-automatic blasts from NVA-held AK-47s. Sau, Phouc, Hiep and Wolken responded instantly. The crack of AK-47 rounds never sounded louder or closer. All I could see from our perimeter was the smoke, the red and orange blasts coming from the darker-than-ever green jungle, and green AK-47 tracers, which were flying over our heads.

The thunderous fury of dozen of men blasting away at each other on full automatic, within 10 or less feet of each other, kills all sounds. Numbs all eardrums.
Then, just as suddenly as the roar had begun, it stopped. Everybody ran out of bullets, except for me, and I emptied my magazine toward the most intense area of enemy fire. The only sounds audible through hurting ears were the metallic clicks of magazines being slammed into hot rifles and gunbolts sliding shut to resume the apocalyptic death roar. ST Idaho won the reload race. Nobody was faster than Sau and Phouc at getting the first magazine out and the second one in. Within seconds we had gained fire superiority. At that instant, at the peak of the fire-fight, those brief, tense adrenaline-pumping seconds made all the other games in life seem like patty-cake. You miss your man here and you die.

The majority of the enemy firing was coming at us from the south and west parts of the small knoll. Wolken and I chucked a couple of M26s down the side of the knoll, in between blasts of full auto on our CAR-15s. As soon as we gained complete fire superiority, I turned on the URC-10 beeper and started screaming into the PRC-25. The small knoll saved us. The jungle was so thick and the knoll so small, only a score of NVA could rush us at once.

Soon they were stacking bodies and firing at us from behind their dead comrades. A lot of NVA soldiers died in those first few minutes of hell on earth. For more than an hour, my cries and screams into the radio and URC-10 beeps went unanswered as the NVA mounted more mass attacks.
But the hill, the jungle and our CAR-15s worked against them as they continued to pile up or drag away more bodies. With no help around, conserving ammo while keeping Charlie back became a top priority.

Waiting several hours for help in the Prairie Fire AO after making contact with the NVA was not unusual. In fact, any time a team got help in less than an hour or two, people boasted about it as though it were a minor miracle because the AO was so far from Vietnam. Finally, I heard Spider on the radio. He said an F-4 Phantom returning from a bombing run in Northern Laos had heard the beeper and called him. told Spider we had a "Prairie Fire Emergency," which diverted all airborne assets in the AO to our target, including any F-4s that were heading north. Spider also said he had called the Judge and the Executioner--an America Division gunship team that was temporarily attached to our operation. Within minutes, Spider was over our position. He told me to pop smoke, Spider said he saw two yellows, which meant the NVA were monitoring our frequency.

We changed frequencies and I popped a violet smoke. A few minutes later, the first A1E Skyraider arrived on target and made a gun run on the western perimeter. He made his first napalm run on the south side and said, "Put your heads down. I'm going to make you sweat."
He brought it so close we could feel the heat from the deadly jell. A few seconds later we smelled burning flesh. As he dove toward us a third time, the pilot said, in a quite Southern drawl, "It's crispy critter time."

When the NVA heard the old World War II plane making another run, they charged us in a desperate attempt to get close to us in order to avoid the Skyraider's deadly ordnance. Then we blasted away and pushed them back down the hill, and the Skyraider pushed them back toward us, like a death dance. Right then and there I thanked the Lord for Uncle Sam's Air Force.

By now, each team member had developed lanes of fire down the hill. At one point when I was talking to Spider, I though I saw something moving in my lane of fire. All I could see was the ass of an NVA soldier crawling up the hill. I told Spider, "Wait one" (second). Then the NVA stuck up his head to se where he was, and the last thing he might have seen was a puff from my CAR-15 as his head exploded like a coconut.
For the next few hours, Spider and I worked numerous fast movers and A1Es, hitting the southern and eastern perimeters hard. The Air Force dumped thousands of mini-gun rounds, 20mm rounds, several 500-pound bombs, numerous napalm and CBU (Cluster Bomb Unit) canisters on the dauntless NVA troops. In between gun runs, Wolken and I would fire our M79s upward, like mortars, thorough one small opening in the jungle canopy.

About half an hour before dusk, Spider told us the Kingbees ere on their way. And by that time, the Judge and Executioner had refueled and reloaded and were returning with them. Ten minutes before the Kingbees arrived, Spider was like a master conductor, running F- 4s and A1Es around our perimeter.

The Judge and the Executioner led the Kingbees into and L which was about 10 yards west of our perimeter. Spider had spotted a little ridge from our knoll to a knoll covered with elephant grass and small trees. The Kingbee could not land, but Captain Thinh roared in, chopping the tops off several small tress, and hovered 10 feet off the ground. ST Idaho ran to the chopper. That wasn't as easy as it sounded. It took us 10 minutes to cover those 10 yards.

The ground was wet and muddy. The elephant grass between 6 and 10 feet tall and thick. Because the grass was so thick I went first, trying to blaze a trail through it. When I fell, Wolken ran, literally ran over me, and plowed forward. When he fell, I returned the favor.

As we moved slowly toward the chopper, the activity around us heightened to a frenzy. The NVA knew what the Kingbee was doing. The NVA knew that they knew we were vulnerable. He directed the Judge and Executioner through gun runs along the eastern perimeter while the Kingbee hovered on the western edge.

Sau and Hiep covered our frantic, desperate drive to the chopper. As the Kingbee hovered about 8 feet above us, Wolken and I threw the other four members into the chopper. At some point during that craziness, I looked up at Capt. Thinh, and he was sitting there as cool as a Rocky Mountain breeze, keeping the aging H-34 hovering while taking numerous hits (the next morning, the maintenance crew counted 48 holes int he ancient ship).

Finally, Wolken told me to get in. By now, my adrenaline was roaring through my body like a berserk subway. I grabbed Wolken by his fatigue jacket and threw the 220-pound staff sergeant into the Kingbee. Then I threw my rucksack and jumped up onto the ladder, where Wolken grabbed me by the shoulder while telling the gunner to get the hell out of there. As Capt. Thinh lifted the Kingbee, Hiep and Sau blasted away out of the port windows, Phouc and Robinson blasted away out of the starboard window and Wolken and I emptied our last magazine into the dark jungle, which had dozens, if not hundreds, of muzzle flashes lighting up the darkness. As we ascended skyward, I fired my last M79 round and dropped my white phosphorous grenade, which looked spectacular against the quickly fading jungle.

Seconds later, the hell and fury and death of the LZ were behind us. Suddenly, the cool night air hit us, as Wolken and I watched the final fleeting moments of the sweetest sunset we had ever seen in our lives. We had survived. How many NVA hadn't survived? Capt. Thinh flew us back to Phu Bai. Before he returned to his base at Da Nang, I climbed up to the pilot's seat and thanked him for saving our lives and told him he never had to pay for a drink in the FOB-1 club again.

Because it was late, I went to the mess hall and got some chow for Sau, Hiep and phouc and ate with them. Sau appeared as though nothing unusual had happened. I had never been so close to thunderous death before. Our meal was somber. Later I went to the club, where an Australian floor show was in progress. A lot of the guys wanted sex. I was happy to be alive. Later, when talking to a friend, I realized I had killed a man, perhaps more than one. The line from an old Doors song surfaced in my mind: "The war is over for the unknown soldier...bullet struck the helmeted head." Silently, I thanked the Lord for sparing me, again.

The 1000 Yard Stare

The 1,000 yard Stare is a look through the obvious, a stare beyond or through to the other side of reality.

It's the stare all combat veterans get after prolonged trips into the boonies and combat, and is usually related to extreme consciousness during the most devastating of experiences, Today it has been better defined as PTSD, Post Traumatic Stress Syndrome.

The 1,000 Yard Stare is the immediate result of PTSD and is what separates the Combat Veteran from the Non Combatant.

I always thought that PTSD was something that only the pencil pushers in the rear suffered from, not us battle hardened Vets.

If you have successfully completed USMC Basic Training, Then you are a Marine and will always be a Marine, male or Female, no Question.

But having been a Grunt in Combat, I did however notice a slight difference between the combat Grunt and those other Marines who had not yet experienced the cracking sound of a 7.62x39 round as it snaps pass your head (*it's the one with your name on it, but fortunately, you moved your head just enough for it to miss or Charlie was a bad shot*)

The difference is the "THE THOUSAND YARD STARE" stemming from the stress related to prolonged Combat. I have to say though, for the Marine who has not yet experienced Combat, there is a different kind of stress, a stress that us combat vets can't relate to, or more likely, have forgotten we once had to deal with the same issue.

Becoming a Marine was the easy part. Being a Marine required constant effort.
Marines are always the first to fight. Anyone who enters the MARINE CORPS, regardless of the era, has a one in 3 chance that he or she will enter a combat zone. Today it's closer to 100%.

Having graduated Basic Training and now understanding for the first time what being a Marine is really about, and what is required of you. One of the biggest problems prior to actually going into combat, is contemplating going into combat, dealing with the ever present questions, What will it be like, will I survive, How hard is my Metal?
All these questions have been answered for us combat vets, hell I'm one of the lucky ones, 3 Purple hearts and a Bronze Star, I've got no more questions.

But I can remember back in Nam, on the few occasions when we would go back to the rear area for some working R&R, those boys in the rear had it real nice, or so it would appear.

Once you really paid attention, you saw a STARE that was similar; they were num for different reasons. They had a different kind of reality to shrug off.

The Combat Vet was actually more in control of his reality than the rear echelon support troops and Chopper Crews. There was much more the Combat Vet could do, to effect his survival. When the SHIT hit the fan, we had options, we took the most appropriate course to eliminate the enemy threat and affect a positive outcome with minimum loss of Marines. Calculation, brute force and cunning saved many Butts.

In the rear, there was far less of chance that you would come face to face with Charlie, but the Rockets and Mortars were always a threat and your personal survival was always left to chance. When SAPPERS hit MAG 16 in Oct 65, aircrews were blown up in their tents, they never knew what hit them, and they had no chance to react. After 3 nights of SAPPER attacks, Lima 3/3 was called in to secure the base. We spent 4 weeks building defensive positions, stringing barb wire and laying trip flares and claymores.

We would share our bunkers at night with the base Ground Crew's, training them to take over once we left. One night we were all sitting in front of our bunker, when a trip-flair went off, and the two Ground Crewman bolted around and into the rear of bunker like a flash of light. My A Gunner and I just sat tight trying to see what had tripped our flair, actually hoping that it was Charlie, but it was just a Dog scavenging for food.

Early Radio: Military Communications

With three rows of triple barb & trip flairs everywhere, it was pretty hard to get inside without being detected, but these two Marines were not experienced and very gun shy, they too were suffering from PTSD.. It took several nights of watch for them to calm down and ease off the switch, by the time we left, their Metal was almost as hard as ours.

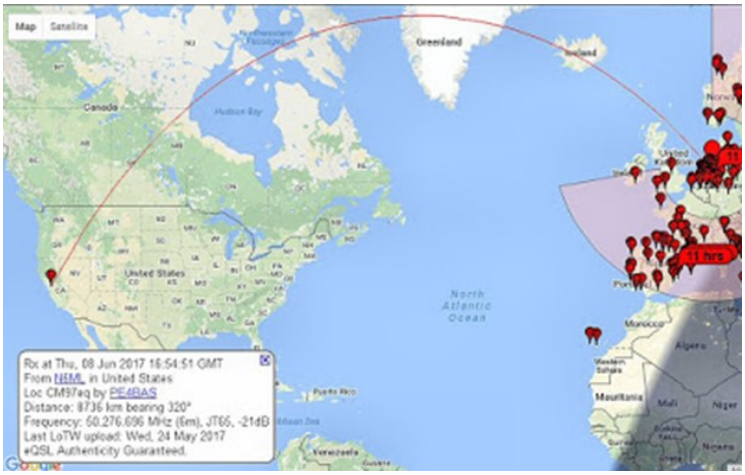
My Brother Flew CH-47's in 69 & 70. He equates his tour as being two very abstract worlds rolled into one. *Rear Area* and *Combat Missions*. He was either flying to work in the Field or Flying home from work to safety. He never experienced any hand to hand combat, never stood watch all alone in the middle of the jungle, and only had one confirmed kill, as a result of this sea-saw lifestyle, he came home very screwed up.

He didn't have the Stare, but he sure did suffer from PTSD. I spent most of my tour in the field, sleeping on the ground and eating C Rations, and always the constant threat of danger that takes a little getting use to.

I had the 1,000 Yard Stare alright, Hell We all had it after our first few times into combat, but I thought I had survived my Vietnam experience in tact, however, after 2 failed marriages, several employment problems and a serious bout with alcohol, I have come to realize that I to have been suffering from PTSD.

Yes, there is a subtle difference between those of us who have seen combat and those of us who have not.
For Marines who have not seen combat, it's just a couple of unanswered questions that separate us.

Another spot intrigues me. N6ML at that time of the day. Strange propagation....



From the ARRL

The 6m band holy grail

For us here in Europe the holy grail of the 6m band would be working Japan on 50MHz. There are several thoughts about how a distance like this can happen. But at least you need ES propagation or Sporadic E just what you like to call it. This happens only a few times a year and only at a small timeslot around 9 UTC it is possible to hear and transmit your signal to Japan. There are years that this doesn't even happen at all. With JT65/JT9 mode it is a lot easier to spot Japan, but a QSO is still difficult as the JT modes are just too slow. However I managed to spot a few Japanese, best distance was 9125km spotted JR2WYD. My neighbour PA0O even worked Korea on 6m for the first time in his 30 years DXing on the 6m band! I was surprised I spotted DS4EOI from Korea today at -16dB myself, that's a great signal on JT65! Think of my antenna system which consists of my Watson W2000 triband at only 6m height and 3 pieces on Aircell7 coax all connected through PL connectors. Crappy 6m setup you would say. Imagine what could happen if I had my mast and 5 element 6m yaup!

ARRL 100 YEARS

Next Regular Meeting

The next meeting will be on **Thursday, June 29th 2017,** at 7:00PM. We meet in the Fellowship Hall of Redemption Lutheran Church, 4057 N Mayfair Road. Use the south entrance. Access the MRAC Yahoo group for important details about the February Meeting.

Meeting Schedule:

September 28th, 7 pm.

Please do not call the church for information!

Club Nets

Please check in to our nets on Friday evenings.

Our ten meter SSB net is at **8:00 p.m.** at **28.490 MHz USB** Our two meter FM net follows at **9:00 p.m**. on our repeater at **145.390 MHz** with a minus offset and a **PL of 127.3 Hz.**

Visit our website at: **www.w9rh.org**

Or phone (414)-459-9741

Name of Net, Frequency, Local Time	Net Manager
Badger Weather Net (BWN) 3984 kHz, 0500	W9IXG
Badger Emergency Net (BEN) 3985 kHz, 1200	NX9K
Wisconsin Side Band Net (WSBN) 3985 or 3982.5 kHz, 1700	KB9KEG
Wisconsin Novice Net (WNN) 3555 kHz, 1800	KB9ROB
Wisconsin Slow Speed Net (WSSN) 3555 kHz, Sn, T, Th, F, 1830	N1KSN
Wisconsin Intrastate Net - Early (WIN-E) 3555 kHz, 1900	WB9ICH
Wisconsin Intrastate Net - Late (WIN-L) 3555 kHz, 2200	W9RTP
ARES/RACES Net 3967.0 kHz, 0800 Sunday	WB9WKO
* Net Control Operator needed. Contact Net Manager for information.	

Higher tick threat this year

Updated: Jul 06, 2011 2:13 PM CST

ROCHESTER, Minn. (FOX 47) -- Babesiosis is popping up all over the upper Midwest.

The Malaria like disease is transported by the black leg deer tick, the same tick that transports Lyme Disease. Minnesota and Wisconsin are the perfect homes for this disease primarily because its host lives here, the white footed mouse. Babesiosis is transferred from mouse to tick and then to humans after a bite takes place.

Once in the blood stream, it has a chance to be fatal, especially for people with an already weakened immune system, because this disease attacks red blood cells.

"Most of the time they are going to be in shrubbery, so about thigh high or waist high or waist high even and they're sitting there looking toward the sky with their little feet out to grasp hold of a deer, a person or whatever it may be that walks by," explains Roger Heimgartner, assistant manager at Whitewater State Park.

Unlike Lyme disease there is no red rash after the bite. This disease is diagnosed by its symptoms which include; Fatigue, high fever, muscle pain, and headaches. Theses symptoms show up about a week after the bite.

The best way to treat this disease is to prevent it. Wear long sleeved shirts, pants, a hat, and use proper repellant. If you see a tick latched on you.

"Remove the tick, probably one of the most important things is not to squeeze the ticks body so that its body contents thereby aren't injected into you by your own action. Some of the old things burn it with a match or put Vaseline on it, that's not so cool," says Heimgartner.

Using a sharp pair of tweezers to gently pull the tick off is also a good way.

VE Testing:

July 29th, 9:30am— 11:30am

No testing: June, August or December

ALL testing takes place at: Ham Radio Outlet 5720 W. Good Hope Rd. Milwaukee, WI 53223

Area Swapfests

July 8th, South Milwaukee 52nd Annual Swapfest Location: Oak Creek, WI Type: ARRL Hamfest
Sponsor: South Milwaukee Amateur Radio Club
Website: http://www.qsl.net/wa9txe/SWAPFEST.HTML

July 9th, Fox River Radio League Hamfest Location: Aurora, IL Type: ARRL Hamfest
Sponsor: Fox River Radio League
Website: http://www.frrl.org/hamfest.php

Membership Information

The Hamateur Chatter is the newsletter of MRAC (Milwaukee Radio Amateurs' Club), a not for profit organization for the advancement of amateur radio and the maintenance of fraternalism and a high standard of conduct. MRAC Membership dues are $17.00 per year and run on a calendar year starting January 1st. MRAC general membership meetings are normally held at 7:00PM the last Thursday of the month except for November when Thanksgiving falls on the last Thursday when the meeting moves forward 1 week to the 3rd Thursday and December, when the Christmas dinner takes the place of a regular meeting. Club Contact Information

Our website address **http://www.w9rh.org**

Telephone **(414)-459-9741**

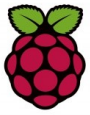
Address correspondence to:

MRAC, PO Box 26233, Milwaukee, WI 53226-0233

Email may be sent to: **w9rh@arrl.net .** Our YAHOO newsgroup:

http://groups.yahoo.com/group/MRAC-W9RH/

MRAC Working Committees
100th Anniversary:



- Dave—KA9WXN

Net Committee:

- Open

Field Day

Dave—KA9WXN, Al—KC9IJJ

FM Simplex Contest

- Joe – N9UX
- Jeff – K9VS

Raffle

- Tom – N9UFJ

Newsletter Editor

- Michael-KC9CMT

Newsletter Proofreader

- Pancho– KA9OFA

Webmaster

- Dave, KA9WXN
- Dale, AB9DW

Refreshments

- Open

CLUB NETS:

- The Six Meter SSB net is Thursday at 8:00PM on 50.160 MHz USB
- Our Ten Meter SSB net is Friday at 8:00PM on 28.490 MHz ± 5 KHz USB.
- Our Two Meter FM net follows the Ten meter net at 9:00PM on our repeater at 145.390MHz - offset (PL 127.3)

Chatter Deadline

The **DEADLINE** for items to be published in the **Chatter** is the **15th of each month**. If you have anything (announcements, stories, articles, photos, projects) for the 'Chatter, please get it to me before then.

You may contact me or Submit articles and materials by e-mail at: W9rhmrac@Gmail.com

or by Post to:

Michael B. Harris

807 Nicholson RD

South Milwaukee, WI 53172-1447

Milwaukee Area Nets

Mon.8:00 PM 3.994 Tech Net

Mon.8:00 PM 146.865- ARRL Newsline

Mon.8:00 PM 146.445+ Emergency Net

Mon.8:00 PM 146.865- Walworth County ARES net

Mon. 8:00 PM 442.100+ Railroad net, also on EchoLink

Mon. 8:45 PM 147.165- ARRL Audio News

Mon. 8:00 PM 442.875+ WIARC net also on EchoLink 576754

Mon. 8:30 PM 146.820 Waukesha ARES Net —

on the 1st, 3rd, and 5th Monday of each month.

Mon. 9:00 PM 147.165– Milwaukee County ARES Net

Tue. 9:00 AM 50.160 6 Mtr 2nd Shifter's Net

Tue. 9:00 PM 145.130+ MAARS Hand Shakers Net

Tue. 8:00 PM 7.035 A.F.A.R. (CW)

Wed. 8:00 PM 145.130+MAARS Amateur Radio Newsline

Wed. 8:00 PM 147.045+ West Allis ARC net

Wed. 8:00 PM 28.365Mhz 10/10 International Net

Wed. 8:00 PM 147.270+ Racine County ARES net

Wed. 9:00 PM 145.130+MAARS SwapNet, Allstar FM-38

Thur. 8:00 PM 50.160, 6 Mtr SSB Net

Thur. 8:00 PM 443.800+ Tech Net

Thur. 9:00 PM 146.910+ Computer Net

Fri. 8:00 PM 28.490 MRAC W9RH 10 Mtr SSB Net

Fri. 9:00 PM 145.390+ W9RH 2 MTR. FM Net

Sat. 7:30 AM MW Classic Radio Net , Freq.—3885 AM

Sat. 8:00 PM 146.910+ YL's Pink HAMsters Net

Sat. 9:00 PM 146.910+ Saturday Night Fun Net

Saturday Night Yaesu Fusion Net 7:00 P.M., W9RH Repeater, C4FM digital mode, using "DN"', digital narrow mode

Sun 8:00 AM, State ARES Net 3967/3977.5/145.470

Sun 8:30 AM 3.985 QCWA (Chapter 55) SSB net

Sun 9:00 AM 145.565+ X-Country Simplex Group

Sun 8:00 PM 146.910+ Information Net

Sun 8:00 PM 28.365 10/10 International Net (SSB)

Sun 9:00 PM 146.910+ Swap Net

Daily: Milwaukee — Rag Chew Net: 7:00 AM, 3850 SSB + Florida Net 7 am, 14.290 mhz.

2 meter repeaters are offset by 600KHz - - 70 centimeter repeaters are offset by 5 MHz

SSB frequencies below 20 meters are LSB and for 20 Mtr and above are USB.

Minnesota/Wisconsin Yaesu System Fusion, Wires-X Technical Net.
Monday Evenings 7:30 P.M. Local Time.

Sponsored By
BARS -Bakken Amateur Radio Society.
Where: On the MRAC repeater,
145.390MHz, Offset -600KHz, PL Tone encode of 127.3.
The Net is carried via a RF Node Link to Wires-X Room (21493) .
The net is held in the Digital Narrow (DN) mode.

2017 Field Day Site. MATC South Campus Grounds