

## **Fish Day Fire - "The Fire Behavior Incident on Division Indigo"**

*Prepared by: Gary M. Curcio, Fire Staff Specialist*

Regional Forester Jim Sain requested that I review and comment on the Fire Behavior that was encountered on Division Indigo by the NC Forest Service D-4 strike team. By the account given, everything seemed to be going fairly well, was under control, and preceding as planned. But unexpectedly there was a change in Fire Behavior, a change for the worse. The wildfire's spread changed direction, previously controlled lines were lost, and a routine fire assignment now became a life threatening situation. What were the underlying causes for such an event to take place? Fires in pocosin type fuels have been studied since the 1950's and although this is 1994, 44 years later, pocosin Fire Behavior still remains a mystery. However, what happened to the D-4 strike was not a rare event, but rather a normal or common Fire Behavior experience that can be typically associated with pocosin fuels.

High intensity pocosin fires have occurred in all seasons of the year under various climatic conditions. They have burned in the winter, summer, fall and spring as well as during periods of drought or extreme wetness. During these times two things are for certain, high intense wildfire runs in pocosin fuels are predictable and "direct suppression control methods" are very likely going to be ineffective and dangerous to implement. The wildfire's intense run will be maintained until either the fuel or the weather conditions change for the better, thereby decreasing the fire's intensity. In reviewing this incident of severe, erratic Fire Behavior, we can only ask ourselves what information was available that could have alerted us to this predictable, expected event.

In suppressing wildfires aggressively we do so by providing for safety first. This is partly accomplished by recognizing current weather conditions, and obtaining forecasts so that suppression actions can be based on current and expected Fire Behavior. The following information was available on May 26, 1994:

1. Conditions for "Blowup Event".
2. National Weather Service (NWS) Zone Weather Forecasts.
3. Remote Automated Weather Stations Data (RAWS) & NFDRS values.

What are the conditions for Blow Up in the NC coastal plain.

- 1) RH < 30%
- 2) FFM < 6.5%
- 3) BUI > 25
- 4) and the predicted instability of the atmosphere or the presence of an unstable atmosphere.

We obtain our weather and fire danger indexes from our weather forecasts and RAWs or fire danger weather stations. Let's review the morning forecast for Thursday, May 26, 1994 (Exhibit 1). What is the predicted RH for Z17? [40%] Is this the correct weather zone to be used for the Fish Day Fire? (yes, but the wildfire is also at the edge of Z16-Exhibit 2). At 1200 hours the same day an updated forecast was issued for Z16 & Z17 (Exhibit 3). The RH was re-forecasted to reach as low as 30%. This update was a direct result of the continued low RH being recorded by the FBA's at the Angola Bay Fire in Pender County (NWS-Z16). So the 1st criteria for Blow Up, low RH levels, was forecasted. In NC the term Blow Up needs to be associated with plume-dominated fires (tall convective column, the chimney effect as described by George Byram) and/or wind-driven surface fire where severe Fire Behavior is going to be experienced. A wildfire of this magnitude can achieve a rate of spread from 1 mile to 7 miles per hour and spotting can be excessive. It can be both long and short distance as well as occurring in advance of the fire's head and its' flanks.

Further review of the NWS Zone Forecast (Exhibit 1) displays four events that can have a serious impact to Fire Behavior on any on-going wildfire.

1. Advancing Cold Front.
2. Questionable Wind Profile.
3. Forecasted Sea Breeze predicted in the adjacent weather zone.
4. Burning Forecast (Smoke Management).

Dr. Ed Brotak has analyzed 10 years of weather data associated with 60 major forest fires. These particular forest fires were all located in the eastern half of the United States. They have burned at least 5,000 acres. One third of the reviewed fires were wildland fires in NC. One of the common denominators that Brotak's study points out was that of all the major fire runs reviewed, 75% of them were associated with the event of cold front passages. So the forecasting of a cold front in the synopsis coupled with fuel condition and existing wildfires warranted a red flag warning.

In the forecast what does a Questionable Profile mean? The terms Adverse, Favorable & Questionable were originated by George Byram and the research work he conducted in the 1950's at the Macon Fire Lab. Byram investigated wind profiles (windspeed and its' change with altitude) and their relationship to a wildfire's behavior. Reviewing Byram's earlier work and Brotak's current work in the late 70's as well as wind profile measurements from the NWS at Cape Hatteras for 5/26/94, an adverse wind profile as described by Byram was experienced at 0700 hours and a profile as described by Brotak was also experienced at 1900 hours (Exhibit 4). These profiles provided the fire every opportunity to make a major run. The tall convective column or chimney as Byram describes was not experienced on the Fish Day Fire according to pilot reports. The smoke column was one that was low and wind driven. It was sheared at 4,500 feet and exhibited periodic rolling vortices along the head and flanks. The Fish Day Fire experienced extreme Fire Behavior, rates of spread (ROS) and "the two worst wind profiles" that have been documented in the literature as being troublesome for fire fighters in the eastern United States. The profiles were present during major fire runs in the eastern United States. Byram's low level jet with decreasing windspeeds with increasing altitude and Brotak's high wind speeds with increasing altitude, (>15 MPH @ surface and >40 MPH @ 10,000 ft.). These wind profiles represent the wind profiles that have been present for the 60 major forest fires that were investigated by Brotak. So having a Questionable Profile in the forecast was a second red flag warning.

Sea Breeze, what is its' impact? It can cause a change in wind direction and thereby change the direction of a fire's spread. This action would pressure existing containment lines that were previously believed secured.

<u>RAWS</u>	All sampled remote automated
WHITEVILLE	weather stations experienced
CATHERINE LAKE	wind shift from the SW (225°)
FAIRFIELD	to S (180°) for a period of
CEDAR ISLAND	1 to 6 hours before returning to
POCOSIN LAKE	surface flow from SW. The
SIMMONS (CROATAN)	common time for all these stations
	appeared to be around 13 to 1400
	hours.

#### Ground Stations

Cherry Point	This temporary wind deflection was also
New River	recorded at two military air stations
New Bern	and a county airport.

This amount of windshift, (30° to 45°), would definitely impact any ongoing control strategies and tactical operations. The Sea Breeze in the adjacent weather zone, Z16, could have well extended its' influence into Z 17, a third red flag. (Sea Breezes basically come in perpendicular off the coast unless the location is at a cape where they would be convergent.)

The Smoke Management Forecast further substantiates the instability of atmosphere. The fourth potential red flag situation within the morning forecast. How many of you are familiar with Lower Atmospheric Stability Index (LASI) or commonly referred as the HAINES'S Index. This index assigns a rating potential for large fire growth. For the day before, and the day of the Indigo incident, atmospheric conditions reached a level 5. This is an excellent rating for small fires to become large fires and exhibit extreme, erratic fire behavior that is wind driven and/or smoke plume dominated. The Haines Index is best suited for plume dominated fires. This is when the power of the fire exceeds the power of the wind and permits the formation of towering convective columns 5,000+ ft. The Haines Index has not been tested on wind driven fires.

Earlier, I asked you to define or state the conditions for Blow Up. It appears that the requirements for RH and atmosphere instability were satisfied. What about fuel moisture levels and the Build Up Index? Reviewing the previous day's 1300 readings, the most recent readings that would have been available to fire fighters, were at critical threshold values.

#### FIRE DANGER VALUES - Exhibit 5

Fire Danger Station	<u>ERC</u>	<u>SC</u>	<u>BI</u>	<u>IC</u>	<u>KBDI</u>	<u>BUI</u>
Whiteville	54	26	83	28	346	56
Jones Lake	60	49	119	32	353	56
Wilmar	42	41	91	21		43
Catherine Lake	57	102	162	57		46
Deppe	50	49	110	28		74
Simmons (Croatan)	42	17	62	8		50

ERC \*From 1970 to 1980 the highest ERC recorded was 66.  
((wind is not an input))

SC Previously recorded high was 102.  
Catherine Lake's anemometer reflects the wind speed above the 75 ft. tree canopy. Catherine Lake has the most unobstructed windspeed sensor while Simmons has the most obstructed. All indicators need to go to top of tower caps for those that are mounted on towers and then adjusted with the appropriate wind reduction factor.

\* Previously highest recorded 160 CL's = 162

BI BI is a reflection of the combined influence of the SC+ERC.

IC All station values were at dangerous levels with the exception of Simmons. IC is a reflection of the influence of FM + Fuel Temp + SC (wind influence) Simmon's anemometer is not in an opportune location.

KBDI New Bern's stations need to start to calculate KBDI. The values from D-8 make lightning strike fires a strong possibility especially if they associated without rain.

BUI All stations and their Build Up Index values meet the criteria for fires exceeding routine fire spreads. The Airforce Bomb Range fire in 1971 reached a final fire size of 29,000 acres when KBDI was 54 and BUI was 28.

The fire danger stations and/or RAWs also provided information concerning the measured and calculated fuel moistures.

RAWs Station	Fuel Moistures - Exhibit 6			
	1 HR.	10 HR.	100 HR.	1000 HR.
Whiteville	7.5	9.4	12.7	22.1
Catherine Lake	8.1	6.6	12.8	21.7
Fairfield	15.8	12.7	12.8	19.0
Cedar Island	12.5	9.2	16.0	21.6
Pocosin Lake	8.2	7.3	14.1	21.7

The 10 Hr. FM trend is very disturbing. It is less than the 100 Hr. FM. The 100 Hr. levels are more in tune with normal 10 Hr. fuel moistures and Fairfield's 1000 Hr. is definitely a red flag situation.

In review, the forest fuel conditions and the weather conditions created an environment for a potentially severe wildfire with extreme rates of speed and spotting problems. As fire fighters we need to stay fully in tune at all times as to what is happening around us. (Look Up, Look Down, Look Around take the time to notice and reflect.) Is a convective column developing? Are cumulus type clouds developing? Are there single or double or multiple rolling vortices at the head or flanks of the fire? Are wind shifts predicted? If the wind shifts occur where are you going to go? Where is your safety zone? Is it immediately accessible? What happened to personnel on Division Indigo is very important and it appears that there are two leading possibilities for the change in the Fire Behavior that was experienced:

- 1) A temporary shift in the wind direction was recorded at many weather stations and probably can be attributed to the Sea Breeze influence.
- 2) Rolling horizontal vortices were a common occurrence on the Fish Day Fire. These comments were obtained from pilot aerial observations. "The smoke column would shift its position from a vertical to a diagonal position, and the horizontal roll outs of smoke were very noticeable".

Firefighters need to constantly monitor the fire's behavior and be prepared to react properly and immediately. The sudden calm, as commented by Division Indigo Strike Team Leader, Tom Harris, is a common warning signal that something is going to happen and has been associated with wind shifts and/or sudden downbursts. Firefighters very often think of wind in narrow terms, surface velocity and direction. Little concern or thought is given to the wind action immediately above the surface. John Crosby wrote, "The stronger the horizontal wind the more turbulent it becomes in its passage over a rough surface, thus creating strong eddies and more gustiness with frequent changes in direction." The Fish Day Fire did not burn forest fuels over rough terrain, but it burned fuels that were on a flat surface of the NC coastal plain. However, the fire's convective current (vertical air flow) superimposed on a very strong horizontal wind profile, created a favorable environment where it is highly probable that the surface winds would be strong and gusty with "frequent changes in direction".

I was originally asked why this wildfire event occurred. With the information that was available, on May 26, 1994, I ask you, why wouldn't it occur? Fire weather and fuel conditions were opportunely primed for the occurence of this event.

GMC/dpb

MESSAGE ID: 094146 0832 DATE: 05/26/94 TIME: 08:32 PRIORITY: 000

TO: BOCOD - OPERATIONS, NCDNR CO  
CO OPERATIONS  
NRCD-FOREST RESOURCES

FROM: BOWX - OFC, NAT'L WEATHER FORECAST  
EHNH-FOREST RESOURCES

SUBJECT: RDU FIRE WX FORECAST - RDU

TTAA00 KRDU 261231

MORNING FIRE WEATHER FORECASTS  
NATIONAL WEATHER SERVICE RALEIGH NC  
8:30 AM THU 05 26 94

SYNOPSIS: HIGH PRESSURE WILL CONTINUE ACROSS THE STATE TODAY. A COLD FRONT WILL ENTER THE MTS OF NC THIS EVE...MOVE EAST TO NEAR A ECG RWI-FAY LINE BY 8 AM FRIDAY THEN MOVE OFFSHORE FRI AFTERNOON. EXPECT MDT RH TODAY ALONG WITH MDT-STG SW WND.

WEATHER TODAY	MAX TMP	MIN RH	WIND DIR AND SPEED	CHC PCPN
ZONES... 1				
PT CLDY/CHC PM TSTM.....	82	55	SW 20G28.....	30 PCT
ZONES... 2				
PT CLDY/CHC PM TSTM.....	89	40	SW 20G25.....	40 PCT
ZONES... 16				
PT CLDY/CHC PM TSTM.....	88	40	SW 15G20 SEA BRZ..	30 PCT
ZONES... 4,14,15,17				
PT CLDY/CHC PM SHWRS/TSTMS..	89	40	SW 18.....	40 PCT
ZONES... 3,5				
VRBLY CLDY/CHC PM SHWRS/TSTM	85	45	SW 18.....	40 PCT
ZONES... 6,7				
VRBLY CLDY/GOOD CHC PM TSTM.	83	45	SW 18.....	50 PCT
ZONES... 8,13				
VRBLY CLDY/GOOD CHC PM TSTM.	86	45	SW 15G20.....	50 PCT

WIND PROFILE ANALYSIS / FIRE CONTROL OVER FLAT TERRAIN  
QUESTIONABLE...MORE ANALYSIS NEEDED...UPDATE TO BE ISSUED

MOUNTAIN REGION WEATHER	TMP	RH	SFC WND SPD / WND AT 1800 FT TO / 4000FT 2800 FT MSL / MSL	CHC PCPN
ZONES... 9				

OCNL SHWRS/TSTMS.....	72	65	18 TO 23G28 / W 27	70 PCT
ZONES... 10,11,12				

OCNL SHWRS/TSTMS.....	77	60	15 TO 20G25 / SW 24	70 PCT
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WEA OTLK FOR TNGT AND FRI ... TONIGHT...SHWRS AND TSTMS LIKELY  
STATEWIDE. HI RH AND MDT-STG SW WND. FRIDAY...MORNING SHWRS EAST  
OTHERWISE PT CLDY. MDT RH AND MDT-STG N-NW WND.

PRECIPITATION AMOUNTS..... 8AM TO 1PM

ZONES 6,7,8,13..... 0.1 IN

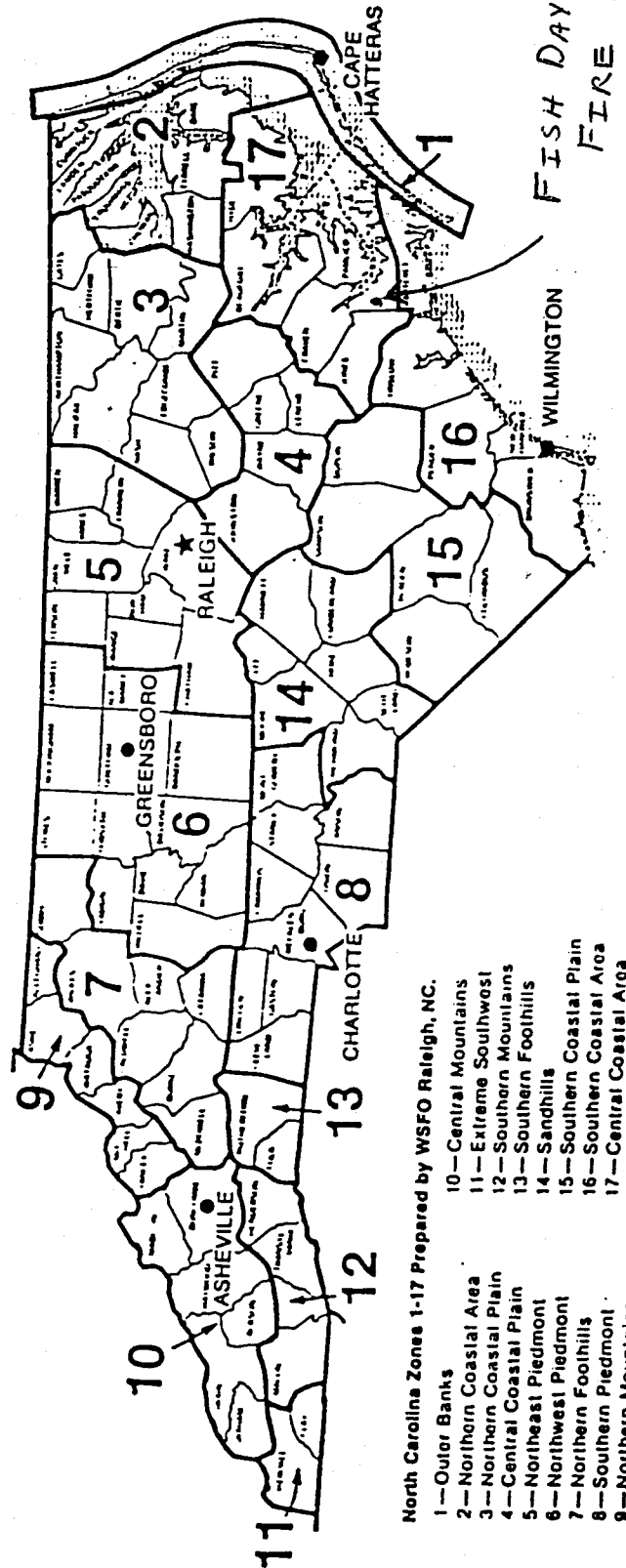
ZONES 9,10,11,12..... 0.4 IN

BURN FCST TDA: MXHT	TW	BURN
MTN RGN..... 7000 FT	SW20 MPH	CAT 5
PDMT/CSTL PLN 7500 FT	SW18 MPH	CAT 5

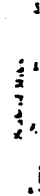
CSTL CNTYS... 7500 FT SW25 MPH CAT 5

APPENDIX B

# NORTH CAROLINA ZONE FORECAST BOUNDARIES



NATIONAL WEATHER SERVICE  
Eastern Region



- ★ Weather Service Forecast Office
- Weather Service Office

North Carolina Zones 1-17 Prepared by WSFO Raleigh, NC.

- 1—Outer Banks
- 2—Northern Coastal Area
- 3—Northern Coastal Plain
- 4—Central Coastal Plain
- 5—Northeast Piedmont
- 6—Northwest Piedmont
- 7—Northern Foothills
- 8—Southern Piedmont
- 9—Northern Mountains
- 10—Central Mountains
- 11—Extreme Southwest
- 12—Southern Mountains
- 13—Southern Foothills
- 14—Sandhills
- 15—Southern Coastal Plain
- 16—Southern Coastal Area
- 17—Central Coastal Area



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## SYSM AUTOMATIC PRINT

MESSAGE ID: 094146 1203 DATE: 05/26/94 TIME: 12:03 PRIORITY: 999

TO: BOCOO - OPERATIONS, NCDNR CO  
CO OPERATIONS  
NRCD-FOREST RESOURCESFROM: BOWX - OFC, NAT'L WEATHER FORECAST  
EHNH-FOREST RESOURCES

SUBJECT: RDU FIRE WX UPDATE - RDU

TTAA00 KRDU 261601

FIRE WEATHER UPDATE

NATIONAL WEATHER SERVICE RALEIGH NC

1200 PM EDT THU MAY 26 1994

TEMPERATURES OVER SOUTHEASTERN NORTH CAROLINA ARE RUNNING ABOUT 2-4  
DEGREES HIGHER THAN EXPECTED...THEREFORE RH VALUES WILL FALL TO NEAR  
30 PERCENT THIS AFTERNOON. SOUTHWEST WINDS WILL CONTINUE TO GUST NEAR  
20 MPH.

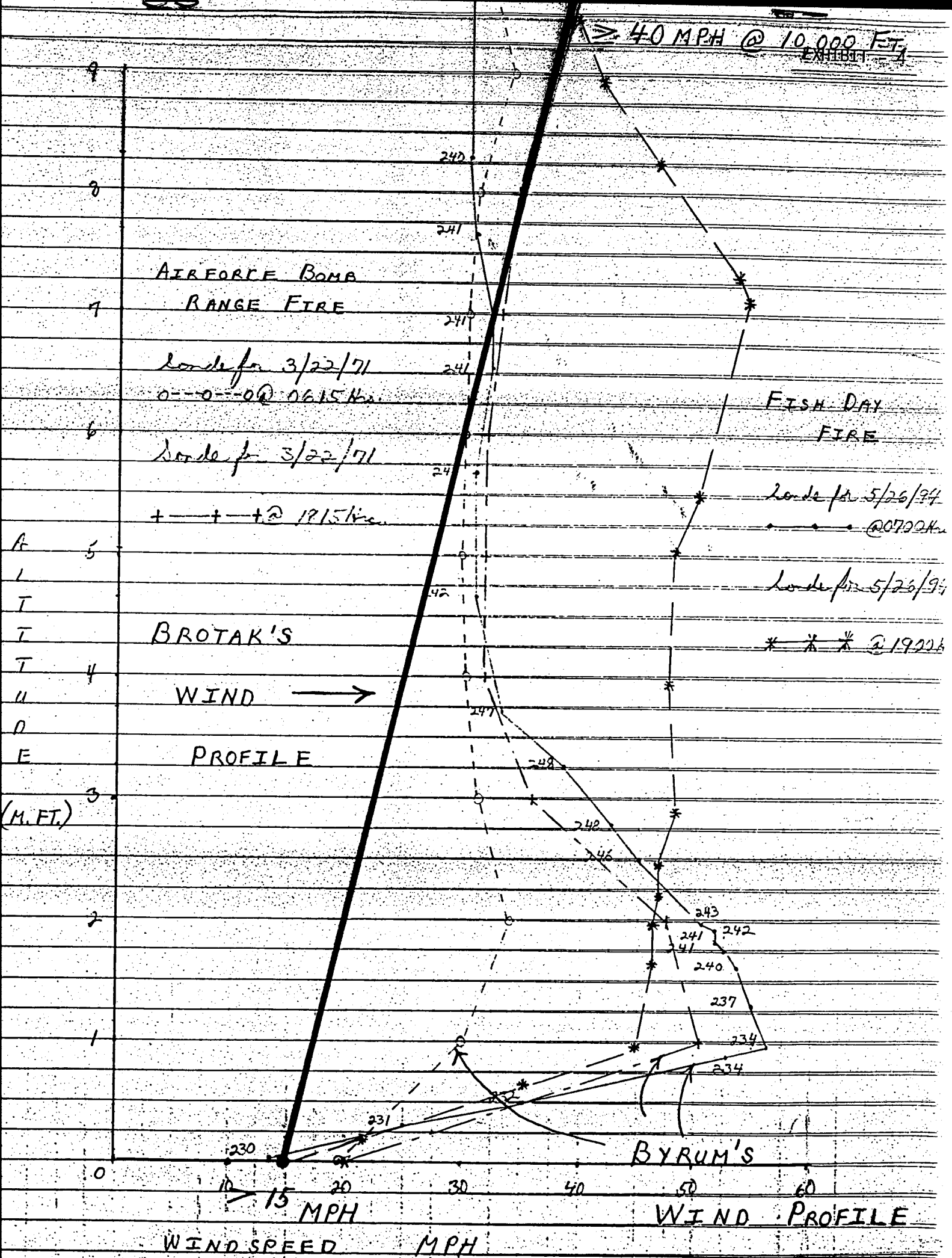
## UPDATED FORECASTS

FOR REMAINDER OF

TODAY	MAX TMP	MIN RH	WIND DIR AND SPEED	CHC PCPN
ZONES... 16				
PT CLDY/CHC LATE PM TSTM....	93	30	SW 15G20 SEA BRZ..	40 PCT
ZONES... 17				
PT CLDY/CHC LATE PM TSTM....	92	30	SW 15G20.....	40 PCT

END MPR

≥ 40 MPH @ 10,000 FT  
EXHIBIT 1



FIRE DANGER VALUES

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