Report SDSMT/IAS/R-89/01 March 1989

ANNUAL PROGRESS REPORT ON T-28 AIRCRAFT FACILITY COOPERATIVE AGREEMENT (ATM-8620145)

By: Andrew G. Detwiler and Paul L. Smith

Prepared for:

Experimental Meteorology Program
National Science Foundation
1800 G Street, N.W.
Washington, DC 20550

Cooperative Agreement No. ATM-8620145

Institute of Atmospheric Sciences

South Dakota School of Mines and Technology

Rapid City, South Dakota 57701-3995

ABSTRACT

This is the annual progress report required under the terms of Cooperative Agreement No. ATM-8620145 between the National Science Foundation (NSF) and the South Dakota School of Mines and Technology (SDSM&T). The agreement provides for operation of the SDSM&T armored T-28 meteorological research aircraft as a national facility for investigations into cloud, thunderstorm, and hailstorm processes. This report covers the period 16 February 1988-15 February 1989. No field projects were supported by the facility during this period, mainly because no suitable projects were carried out by the U.S. atmospheric sciences community. The main activities were a major reconfiguration of the instrument pylons and wiring on the aircraft; acquisition of a new on-board data acquisition system; planning for field projects scheduled for the spring and summer of 1989; and the preparation of results from various earlier field projects for publication.

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1. INTRODUCTION

Extensive refurbishing and upgrading of the armored T-28 research aircraft took place during the second year of the facility cooperative agreement. The pods for the Particle Measuring Systems (PMS) probes were relocated to new pylons outboard of the previously-used mounting points, and the instrumentation system was completely rewired. A new data acquisition computer system was ordered and should be delivered about the time this report is completed. These actions resulted in a substantial weight saving (about 150 lbs) that can be used to accommodate user-furnished instrumentation. Moreover, the data recording will be merged into a single common data tape, in contrast to the old dual data acquisition system arrangement with two separate tape drives. Its capacity is adequate to eliminate concerns about running out of tape during a research flight.

In regard to support of field projects, 1988 was, in some ways, a disappointment for the T-28 facility. The two major field projects in which T-28 participation had been planned were cancelled, or at least postponed. These were the Precipitation Augmentation for Crops Experiment (PACE) in Illinois and the Hailswath II experiment in North Dakota. The PACE program is now scheduled to hold its field experiment in the spring of 1989 and the North Dakota Thunderstorm Project scheduled for June and July 1989 includes some of the elements of the Hailswath II project that was originally planned for 1988. The T-28 facility has been allocated to support both of these projects, so we look forward to 1989 being an extremely busy year. The nine weeks we plan to spend in the field this summer are comparable to some of the busiest T-28 seasons in the last 18 years. We hope to make major contributions to cloud physical studies as part of both of these projects.

The second year of our facility agreement was very busy, not only with regard to the acquisition of new equipment and refitting of the aircraft (summarized in the next section), but also with regard to preparation of results from previous T-28 field projects for publication. Section 5 summarizes the latter activity. Other facility activities are also discussed in Sec. 2, while Sec. 3 outlines future plans for the facility. Section 4 discusses key facility personnel, and Sec. 6 presents a proposed budget for the next year of facility operation.

2. PROGRESS DURING THE YEAR

2.1 Hardware and Equipment

During the second year of the agreement, the acquisition of the equipment included in the approved budgets for the first two years was essentially completed. The major exception is the improved tape drive that had been planned for our existing data acquisition system. Because in this year we completed the procurement of an entirely new data system for the aircraft, the need for this 9-track tape drive disappeared. Some of the funds previously budgeted for this purpose were used instead to help acquire a 9-track tape drive for our VAX minicomputer system on the SDSM&T campus. This makes two tape drives available on the system and facilitates the handling and reduction of large data sets, such as the PMS image data, on the VAX. Some of the remaining funds will be used to acquire a second cartridge tape drive for use in playing back the flight tapes for quick-look data reduction with our new data system. Cost savings in other areas will also make it possible to procure a ground-station PC, to facilitate the quick-look reduction, from second-year funds.

Other items not yet acquired include:

1. The pressure washer; this will not be needed now because the new paint job on the aircraft has made it fairly easy to keep clean.

2. The carburetor overhaul; with funds provided by the SDSM&T Foundation, we are negotiating a trade with the University of Washington for a Quick Engine Change (Q.E.C.) kit for the T-28, that includes a carburetor. It it meets the FAA certification standards, the planned overhaul of an existing spare carburetor will not be necessary.

In the area of hardware and equipment, the following major items were also completed this second year. The new propeller and deicing boots acquired last year were inspected, refurbished, and installed on the aircraft; this will enhance the aircraft on-station time. Completely new instrumentation wiring was installed in the aircraft wings and fuselage; the resulting weight reduction increases our capability to carry user-supplied instrumentation. Two new instrumentation pylons were fabricated and installed, one on each wing; this will mitigate concerns about the skin stresses associated with the previous single-pylon mounting for the PMS probes. A backup dynamic pressure transducer was purchased; together with the static pressure transducer obtained from NCAR surplus stock, it provides a routine dual sensing capability for the important dynamic and static pressure variables.

The new data acquisition system has arrived from Science Engineering Associates. This is an important start on the facility upgrade proposed in 1987. The system, based on an industrial-grade

PC, represents a significant increase in data capacity and a significant decrease in weight and power requirements over our old data system. All particle images, as well as meteorological and operational data, will now be recorded on a single streaming cartridge tape. For the cockpit, a new front pedestal has been designed and fabrication partially completed. There will be a new cockpit display system to go along with the new data acquisition system, and an in-flight rebooting capability will be available.

Other activity included installation and flight test of a pair of electric field mills borrowed from New Mexico Institute of Mining and Technology. A test flight on which the mills were carried provided some calibration data for use with the 1986 COHMEX field mill observations currently under analysis. Our two dynamic and two static pressure transducers have been moved to the baggage bay, to facilitate access for pressure calibrations, and the associated plumbing has been redone. A new audio stereo recorder has been installed in the cockpit, to replace the previous unit which had become unserviceable.

Significant effort has been put into calibrating and maintaining the calibration of the T-28's research instrumentation. All of the pressure transducers and the reverse-flow temperature sensor are being calibrated this month at the Research Aviation Facility at NCAR. We have also completed fabrication of a portable refrigeration unit that can be used to check the reverse-flow temperature instrument in the field.

We completed a flight test in early November during which the T-28's newly-installed equipment and instrumentation worked properly, with two exceptions. The PMS 2D-C probe, which is now the property of the Research Aviation Facility at NCAR, still appears to have some electronic problems that lead it to sporadically produce images that are squashed in the direction of flight. A good example of the onset of this phenomenon right in the middle of a penetration was found in the data from the 1987 North Dakota project. We are continuing discussions with NCAR as to how we might remedy this situation. The other exception was our J-W probe; it looks like the installed sensing head did not operate properly. Either it can be repaired or we will have to substitute one of our other heads for the upcoming field seasons.

It was a surprise to recently receive a request for use of the Pertec 9-track tape drive from our old PMS DAS-32 data system. It turns out that we have perhaps the only remaining, working unit of this particular type, which is the tape drive for which the early PMS data acquisition systems were designed. The request is still pending.

2.2 Software

The T-28 facility is now reasonably self-sufficient in software to perform all types of analysis on data from all of our instruments,

including the 2-D imaging probes. As a matter of fact, we have come to the point where we can supply our software to facility users so that they can analyze T-28 data themselves.

The new data system we are acquiring is run by software written in the C language. The next two months before we head to Illinois in May will be very busy as we try to adapt to this new software and develop ways of preparing data acquired with it for reduction and analysis using the existing software on our VAX minicomputer system. We will also need to develop procedures for quick-look data reduction in the field.

2.3 Instrumentation Development

The facility scientist has been working with Vernon Plank at the Air Force Geophysical Lab and Hillyer Norment, a private consultant, on further development of Plank's invention which he calls the M-meter. This instrument is intended to measure the total mass concentration of condensate (including both cloud and precipitation particles). Flight tests of this instrument were performed in a piggyback mode during October 1988 by the Research Aviation Facility at NCAR.

Analysis of the data, along with earlier data obtained by Plank during some AFGL flights, has shown some surprising results. The active component of the M-meter is a grooved spinner. Plank's original concept was to develop a spinner that would entrain cloud and precipitation particles in its grooves and slow down in proportion to the mass loading of these particles in the air flowing through the spinner. It turns out that the presence of very small particles (of the size of cloud droplets) in air causes the spinner to spin faster than it would in clear air at the same true airspeed. (In effect, the cloud droplets increase the air density.) The presence of precipitation-size particles, on the other hand, causes the spinner to rotate more slowly than it would in clear air at the same airspeed. Norment is at the moment seeking funding to continue development of the M-meter, and this facility plans to cooperate with him in further analysis of existing data as well as new tests in laboratory wind tunnels and in flight.

2.4 Data Exchanges

During the past year, we have sent digital data tapes from the COHMEX (1986) flights as well as analysis software to Peter Ray's laboratory at Florida State University. In addition, we have supplied information on mass loading in the rain shafts on convective clouds to the U.S. Marine Flight Facility at Cherry Point and to several airframe and aircraft engine companies dealing with apparent engine shutdowns during penetration of rain and/or hail shafts. We have also supplied photographic material to Bill Cotton and Andy Heymsfield for use in publications and presentations which they have been preparing.

2.5 Travel by Facility Personnel

The facility manager attended the spring and fall 1988 RAF Advisory Panel meeting at NCAR, where allocations of NCAR and university facility aircraft were discussed. The facility scientist presented a paper at the American Meteorological Society's 15th Severe Local Storms Conference in Baltimore in February 1988, and also attended the fall Advisory Panel meeting. Both attended the Airborne Instrumentation Workshop which was held at NCAR following the fall Panel meeting.

The aircraft mechanic transported the long-blade propeller to Minneapolis in April 1988 for inspection and certification prior to installation on the aircraft. The facility scientist and the pilot attended a planning meeting for the North Dakota Thunderstorm Project in early February 1989.

2.6 Promotional Activities

Our Bulletin 87-1 describing the T-28 facility has been revised to reflect the recent changes in the aircraft and instrumentation configuration and reissued as Bulletin 89-1. Copies have been sent to several prospective users of the facility.

A poster presentation was prepared for the 3rd Airborne Geoscience Workshop, held during the week of 20 February 1989. This interagency workshop provided an opportunity to describe the T-28 facility to a wide variety of people from different agencies. Registration for the workshop exceeded 150 people. The T-28 is now routinely listed in the table of research aircraft performance characteristics in the quarterly Airborne Geoscience Newsletter.

An invited presentation to the Air Force Academy has been tentatively scheduled for the spring of 1989.

3. FUTURE PLANS

3.1 Research Projects to be Supported

T-28 facility support has been allocated to the PACE project in Illinois during May 1989 and to the North Dakota Thunderstorm Project (NDTP) during June and July 1989. The former project is under the auspices of the Federal/State Cooperative Program in Weather Modification Research, funded through NOAA, and will involve cost recovery funds. The scientific emphasis in the PACE studies will be on investigating microphysical and kinematic variables in moderate-sized convective clouds selected for seeding for dynamic effects.

The NDTP also involves support from the Federal/State Cooperative Program, with the field deployment costs of the T-28 to be paid from that source. However, the principal investigators are funded through an NSF grant, so no cost recovery will be involved. The scientific emphasis will be on studies of transport and dispersion in small to moderate convective clouds, including questions of hailstone embryo sources and transport. The T-28 will carry an improved version of the sulfur hexafluoride analyzer used in 1987, and may also have field mills installed. The reduced weight and space requirements of the new data acquisition system will make it possible to carry this equipment without omitting any part of the recorded data (as was necessary in the 1987 North Dakota project).

3.2 Future Projects

At the moment, no specific requests are pending for use of the T-28 beyond the summer of 1989. However, preliminary discussions have been held with potential participants in several future projects. One is a program of convective storm and mesoscale studies (FAME or STAMP) being planned for the Florida area, concentrated around the Kennedy Space Center. This will not occur before 1990, and perhaps will occur even later. Another program being tentatively planned for the 1990 timeframe is COPS, which is a program of convective storm studies being planned by scientists at the National Severe Storms Laboratory and the University of Oklahoma, Department of Meteorology. A third future program in which the T-28 might participate involves atmospheric, electrical, and chemical studies of convective storms in the Socorro, New Mexico, area. Preliminary work this summer will determine the extent and timing of a major field program in New Mexico at some point in the future.

Future convective storm studies in the western North Dakota area are planned on an every-other-year basis going into the 1990's. The T-28 participated in a 1987 field experiment in this region, carrying a sulfur hexafluoride detector in a three-aircraft tracer experiment studying in-cloud transport and dispersion processes. It will perform

similar duties in the North Dakota Thunderstorm Project this coming summer, and it is likely that future elaborations of this experiment will continue in North Dakota. Finally, it is anticipated that the T-28 will be an important participant in the STORM-Central program planned for the early to mid-1990's in the central plains area. It remains the only aircraft in the research fleet capable of detailed microphysical, dynamical, and electrical measurements in the interiors of large convective storms containing moderate to large size hail.

3.3 Facility Development Activities

Work to maintain the aircraft and associated instrumentation and data system will continue as required. The new on-board data acquisition system represents a significant upgrade which will enhance this summer's project support activities. The most pressing need now is for a ground-station computer compatible with the on-board system, to be used for quick-look data reduction in the field. The procurement process will be initiated this spring, but a borrowed unit will be available for this purpose if delivery does not occur in time for the project operations.

The third-year budget includes provision for an air-to-ground digital data telemetry system. Compared to the limited-capacity analog telemetry system currently available, this new system will enhance our ability to relay observations to the meteorologist directing the flights from the ground. That will improve the process of adapting the flight operations (altitudes, penetration tracks, etc.) to conditions indicated by the data, and thus lead to data of higher quality. Addition of such a system to the facility was viewed favorably by the fall 1987 review panel.

Inquiries have been made to the NSF Program Director for Meteorology about the possibility of obtaining supplemental funding for a permanent electric field mill installation on the T-28. Other upgrades as recommended by the fall 1987 review panel are pending as funds become available.

4. KEY PERSONNEL

There have been no changes in key personnel since the inception of the cooperative agreement. Norm Vine, the T-28 pilot since 1981, has encountered difficulty in getting his FAA medical certification renewed. At this time, the problem has not been resolved.

5. PUBLICATIONS

Work on several manuscripts reporting results of previous T-28 projects has been supported in full or in part under this agreement. They are listed below, with indications of other sources of support where appropriate.

Blackmore, W. H., III, D. J. Musil, P. L. Smith and A. Waldvogel, 1989: Spatial and temporal variations of the interior characteristics of Swiss thunderstorms. [Being revised in response to reviews from Atmos. Res.]

Bringi, V. N., S. Sur, D. J. Musil, P. L. Smith, and R. Rasmussen, 1989: Microphysical evolution of convective clouds inferred from multiparameter radar measurements and aircraft penetrations. [To be presented at 24th Conf. Radar Meteor., Tallahassee, FL. (Jointly supported by a NASA grant.)

Detwiler, A. G., 1988: Comment on "Homogeneous nucleation rate for highly supercooled cirrus cloud droplets." [Accepted by J. Atmos. Sci.]

Detwiler, A. G., 1988: Geographic variation of severe storm microphysics and dynamics. Preprints 15th Conf. Severe Local Storms, Baltimore, MD, Amer. Meteor. Soc., 351-353.

Detwiler, A. G., and P. L. Smith, 1989: Thunderstorm observations with the armored T-28 aircraft. Presented at 3rd Interagency Airborne Geoscience Workshop, San Diego, CA, February 1989.

Musil, D. J., and P. L. Smith, 1989: Hail growth processes in an Alberta hailstorm. [Accepted by J. Wea. Modif.]

Musil, D. J., and P. L. Smith, 1988: Interior characteristics at mid-levels of thunderstorms in the southeastern United States. Preprints 10th Intnl. Cloud Physics Conf., Bad Homburg, FRG, Amer. Meteor. Soc., 638-640. (Supported mainly by a NASA grant.)

Musil, D. J., and P. L. Smith, 1989: Interior characteristics at mid-levels of thunderstorms in the southeastern United States. [Submitted to Atmos. Res.] (Supported mainly by a NASA grant.)

Musil, D. J., R. A. Deola and P. L. Smith, 1989: Vertical velocity regions of southeastern Montana hailstorms. [Being prepared for submission to J. Appl. Meteor.] (Supported mainly by another NSF grant.)

Smith, P. L., and A. Waldvogel, 1988: On determinations of maximum hailstone sizes from hailpad observations. J. Appl. Meteor., 28. [In press]

Stith, J. L., A. G. Detwiler, R. F. Reinking and P. L. Smith, 1989: Investigating mixing and the activation of ice with gaseous tracer techniques. [Submitted to Atmos. Res.] (Jointly supported by the North Dakota Federal/State Cooperative Program.)

Stith, J. L., M. K. Politovich, R. F. Reinking, A. G. Detwiler and P. L. Smith, 1988: Investigating mixing and the activation of ice with gaseous tracer techniques. Preprints 10th Intnl. Cloud Physics Conf., Bad Homburg, FRG, Amer. Meteor. Soc., 588-590. (Jointly supported by the North Dakota Federal/State Cooperative Program.)

Willemse, S., A. G. Detwiler and J. H. Helsdon, Jr., 1988: Electric field measurements with a T-28 aircraft. Presented at Fall 1988 AGU Meeting, San Francisco, CA. (Jointly supported by a NASA grant.)

Willemse, S., A. G. Detwiler and J. H. Helsdon, Jr., 1989: Electric field measurements with a T-28 aircraft. [Submitted to J. Geophys. Res.] (Jointly supported by a NASA grant.)

6. BUDGET INFORMATION

6.1 General

This is a request for third-year funding under a four-year cooperative agreement. This third year total cost is $197,375, less the $4,375 anticipated user fee (cost recovery) funds for year two, less $3,000 anticipated residual funds, making the request to NSF for new monies equal to $190,000. The amount is $5,000 less than the original third year budget of $195,000.

6.2 Salaries and Benefits

Salary rates are those set by the Regents of Education of the State of South Dakota for college FY1989 and inflated by 5% for FY1990. (Actual approved FY1990 rates will be charged the sponsor.)

6.3 Permanent Equipment

An air-to-ground telemetry system is being requested in this third year of the agreement at an estimated cost of $7,500.

6.4 Indirect Costs

The latest indirect cost rate approved by the cognizant government audit agency of the South Dakota School of Mines and Technology is 40.0% of salaries and wages, exclusive of overtime. All salaries and wages in this renewal qualify for the on-campus rate.

The cognizant government audit agency for this institution is:

Director, Division of Cost Allocation
Regional Administrative Support Center
Department of Health and Human Services
Room 1185, Federal Office Building
1961 Stout Street
Denver, CO 80294

6.5 Cost Sharing

This budget will not be charged for the effort expended by the T-28 scientist, Dr. A. G. Detwiler. The State of South Dakota has appropriated some funds to support this position as cost-sharing. Dr. Detwiler will be cost shared at 10 months of effort and Dr. Smith at 0.4 months for this third year funding; thus, the cost sharing including benefits and overhead is $65,551.

THIRD YEAR

(SEE INSTRUCTIONS ON REVERSE BEFORE COMPLETING)

SUMMARY PROPOSAL BUDGET

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PROPOSAL NO. | DURATION (MONTHS) Proposed | Granted

AWARD NO.

ORGANIZATION: Institute of Atmospheric Sciences
South Dakota School of Mines and Technology

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR: Paul L. Smith

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.6. show number in brackets)	NSF FUNDED PERSON-MOS CAL.	ACAD.	SUMR.	FUNDS REQUESTED BY PROPOSER	FUNDS GRANTED BY NSF (IF DIFFERENT)
1. P.I.: P. L. Smith	1.2			$ 9,652	$
2. Res. Sci.: A. G. Detwiler				-0-	
3.					
4.					
5. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)					
6. (2) TOTAL SENIOR PERSONNEL (1-5)	1.2			9,652	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. (4) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	26.3			84,209	
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. (1) SECRETARIAL-CLERICAL				3,372	
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$ 97,233	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				15,557	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$ 112,790	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $1,000.): 1. Telemetry system.					
TOTAL PERMANENT EQUIPMENT				7,500	
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)				6,960	
2. FOREIGN				2,000	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $					
2. TRAVEL					
3. SUBSISTENCE					
4. OTHER					
TOTAL PARTICIPANT COSTS				-0-	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				7,688	
2. PUBLICATION COSTS/PAGE CHARGES				2,130	
3. CONSULTANT SERVICES				-0-	
4. COMPUTER (ADPE) SERVICES				508	
5. SUBCONTRACTS				-0-	
6. OTHER				18,906	
TOTAL OTHER DIRECT COSTS				29,232	
H. TOTAL DIRECT COSTS (A THROUGH G)				158,482	
I. INDIRECT COSTS (SPECIFY) On-Campus Rate @ 40.0% of Total Salaries and Wages					
TOTAL INDIRECT COSTS				38,893	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				$ 197,375	
K. RESIDUAL FUNDS and Cost Recovery Funds				7,375	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 190,000	$

PI/PD TYPED NAME & SIGNATURE*: Paul L. Smith /Paul L. Smith — DATE: 13 Mar 89

INST. REP. TYPED NAME & SIGNATURE*: Timothy G. Henderson Sharon L Reid for — DATE: 14 Mar 89

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Date Checked | Date of Rate Sheet | Initials - DGC | Program

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*SIGNATURES REQUIRED ONLY FOR REVISED

BUDGET EXPLANATION PAGE

Third Year: 15 May 1989-14 May 1990

	COLLEGE FY	EFFORT MAN-MO	MONTHLY SALARY	REQUESTED FUNDS	MAN-MO	COST SHARING FUNDS
A. SENIOR PERSONNEL:						
1. Principal Investigator						
P. L. Smith	1989	0.20	$ 6,611	$ 1,322	0.00	-0-
	1990	1.20	$ 6,942	8,330	0.40	2,563
2. Research Scientist						
A. G. Detwiler	1989	0.00	$ 4,017	-0-	1.50	5,678
	1990	0.00	$ 4,218	-0-	8.50	33,779
Subtotal				$ 9,652		$ 42,020
B. OTHER PERSONNEL:						
2. Other Professionals						
a. Research Engineer						
G. N. Johnson	1989	0.75	$ 4,360	3,270		
	1990	5.25	$ 4,578	24,035		
b. Programmer						
K. R. Hartman	1989	0.75	$ 2,537	1,903		
	1990	5.25	$ 2,664	13,986		
c. Research Pilot						
N. R. Vine	1989	0.40	$ 4,285	1,714		
	1990	2.60	4,499	11,697		
d. Aircraft Mechanic						
J. E. Leigh	1989	1.50	$ 2,337	3,506		
	1990	9.82	$ 2,454	24,098		
5. Secretarial	1989	0.30	$ 1,617	485		
	1990	1.70	$ 1,698	2,887		
	Subtotal			$ 87,581		
TOTAL SALARIES AND WAGES:				$ 97,233		$ 42,020
C. FRINGE BENEFITS:						
1. Staff @ 16.0% of Salaries and Wages				$ 15,557		$ 6,723
TOTAL SALARIES, WAGES, AND BENEFITS:				$ 112,790		$ 48,743

*Salaries include a vacation accrual ajustment.

BUDGET EXPLANATION PAGE

Third Year: 15 May 1989-14 May 1990
(continued)

	REQUESTED FUNDS
D. PERMANENT EQUIPMENT: Telemetry System	7,500
Subtotal	$ 7,500
E. TRAVEL:	
1. Domestic	
a. Travel to project planning meetings and scientific conferences	4,851
b. Local mileage for required travel between campus and airport (T-28 location)	2,109
Subtotal	$ 6,960
2. Foreign	
a. Travel to workshop on aircraft wind/ turbulence/position measurement (West Germany)	2,000
Subtotal	$ 2,000
G. OTHER DIRECT COSTS:	
1. Materials and Supplies	
a. Miscellaneous small parts and repairs to support operation of T-28 and instrumentation system	3,600
b. Fuel/oil for T-28 test flights (24 hrs @ $122/hr)	2,928
c. Fuel oil for heating hanger (600 gal @ $1.10/gal)	660
d. Miscellaneous supplies	500
Subtotal	$ 7,688
2. Publication costs	
a. Paper for scientific conference	300
b. Journal paper (12 pgs @ $110/pg) + ($150 for reprints)	1,470
a. Miscellaneous reproduction	360
Subtotal	$ 2,130

BUDGET EXPLANATION PAGE

Third Year: 15 May 1989-14 May 1990
(continued)

	REQUESTED FUNDS	COST SHARING FUNDS
G. OTHER DIRECT COSTS: (continued)		
4. Computer (ADPE) Services		
a. VAX; est. 120 hrs @ $4.23/hr	508	
Subtotal	$ 508	
6. Others		
a. Propeller inspection	1,000	
b. Rental of hangar/shop facility (includes electricity), 12 mo @ $447/mo	5,364	
c. Telephone service for hangar/shop, 12 mo @ $46/mo	552	
d. Trash collection service, 12 mo @ $23/mo	276	
e. Liability coverage on T-28 and accident insurance for pilot	6,372	
f. Annual subscription to federal airworthiness directives	627	
g. Maintenance and repair services that are beyond in-house capability	3,600	
h. Long distance telephone calls	331	
i. Miscellaneous services	784	
Subtotal	$ 18,906	
H. TOTAL DIRECT COSTS:	$ 158,482	$ 48,743
I. INDIRECT COSTS: On Campus Rate @ 40.0% of Total Salaries and Wages	$ 38,893	$ 16,808
J. TOTAL COSTS:	$ 197,375	$ 65,551
K. Residual Funds	$ 3,000	
Anticipated cost recovery funds from 2nd year	$ 4,375	
L. AMOUNT OF THIS REQUEST	**$ 190,000**	

7. CURRENT AND PENDING SUPPORT

7.1 Principal Investigator, Paul L. Smith

A. Current Support:

1) Supporting Agency: North Dakota Atmospheric Resource Board
Project Title: Provide Personnel and Services for Acquisition and Analysis of Data to Evaluate Operational Weather Modification Activities
Award: $149,800
Period of Award: 1 Aug 1988-30 June 1989
Commitment: 2.5 months
Location: Analysis is at Rapid City, SD

2) Supporting Agency: National Aeronautics and Space Administration
Project Title: Microphysical and Electrical Structure of Small Convective Systems in the Southeastern Part of the United States
Award: $60,969
Period of Award: 20 May 1988-19 May 1989
Commitment: 1.1 months
Location: Rapid City, SD

3) Supporting Agency: National Science Foundation
Project Title: Armored T-28 Aircraft Facility for Research Requiring Storm Penetrations
Award: $190,000
Period of Award: 15 May 1988-14 May 1989
Commitment: 1.8 months
Location: Rapid City, SD

4) Supporting Agency: DRI, Univ. of Nevada-Reno
Project Title: T-28 Research Aircraft Support of 1989 Illinois Fed/State Cooperative Program Investigations (PACE)
Award: $70,024
Period of Award: 1 Jan 1989-30 Jun 1989
Commitment: .45 month
Location: Rapid City, SD

5) Supporting Agency: National Science Foundation
Project Title: Aircraft and Radar Investigations of Hailstorm Processes as Part of Hailswath II
Award: $139,400
Period of Award: 15 Feb 1989-14 Feb 1990
Commitment: 3.0 months
Location: Rapid City, SD

B. Pending Support: (Paul L. .Smith, continued)

1) Supporting Agency: North Dakota Atmospheric Resource Board
Project Title: Continued Research Investigations Related to the North Dakota Cloud Modification Project
Amount Requested: $99,100
Period of Request: 1 July 1989-28 Feb 1990
Commitment: 1.25 months
Location: Rapid City, SD

2) Supporting Agency: National Aeronautics and Space Administration
Project Title: Microphysical and Electrical Structure of Small Convective Systems in the Southeastern Part of the United States
Amount Requested: $48,892
Period of Request: 20 May 1989-19 May 1990
Commitment: 1.2 months
Location: Rapid City, SD

3) Supporting Agency: National Science Foundation
Project Title: Armored T-28 Aircraft Facility for Research Requiring Storm Penetrations
Amount Requested: $190,000
Period of Request: 15 May 1989-14 May 1990
Commitment: 1.8 months
Location: Rapid City, SD