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unless specifically noted.

ON THE COVER

A THATCHED HUT — native living quarters near Nakhon Phanom, Thailand — provides an interesting backdrop for men
on special field assignments. Read more about these men in CONTRACTOR FIELD SUPPORT.

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It's not so much how far you go as what you see. It's not so much how much you see as what you learn from what you see. It's not so much how much you learn as what you do with what you learn from what you see as you go, wherever you go.

The 111 LOG staff has tried to help you learn from what you see where ever the magazine stories have taken you. We hope that you have been able to put to good use the information in the LOG, and that you will continue to find it as beneficial as your letters to the editor have indicated.

As calendars all over the world hold only two more months of the 1968 year, people tend to reflect on all that has happened thus far. Our opening thought this month encourages reflections of 1968 with the hope that the 111 LOG, as well as November and December, will round out the year to suit your taste.

The first LOG entry this month is entitled "Contractor Field Support." Fort Worth division Field Support personnel are presently assigned at customer test sites, training sites, operational bases (both in the United States and overseas), depot maintenance facilities, and at Air Force/Air Command headquarters. Because Fort Worth division Field Support personnel are limited in number by location, yet have virtually unlimited backup support from the home office, it is the intention of this article to depict the entire function of this section of 111 Logistic Support.

An interesting portfolio of photographs accompanies the text.

"When it Happens" is the second LOG story in the November issue. Highlighting accident prevention, this article features a dialogue section to help illustrate how the combined efforts of the customer and General Dynamics are geared to help when help is needed in the air. The services provided in this area are indeed noteworthy.

"The most critical factor in the successful implementation of any logistics operation is the capability to move material and supplies efficiently in a short period of time." This is an excerpt from the next article — "Warehouse and Storage Facilities at General Dynamics, Fort Worth Division." This feature tells about the new material support plan, the more advanced equipment, and the better layout of warehousing and storage areas that were designed to increase efficiency and decrease costs. Topical sections of the story include receiving, storage, distribution, shipping, and administration as well as background information about previous warehousing facilities at the Fort Worth division.

With cold weather descending upon us, the second annual November version of "Do You Know . . ." focuses attention on wind chill. The latest Air Weather Services (AWS) Equivalent Chill Temperature Chart in "Do You Know" will provide a handy wintertime reference for you. The chart serves as a guide to the cooling effect of the wind on bare flesh when first exposed.

From 1793 to 1967 crew escape systems have progressed from a simple parachute jump from a balloon to the sophisticated 111 crew module in-flight ejection. Throughout the 174-year history of aircrew escape systems the main purpose has been to provide crew members with an open avenue of escape when needed. To learn more about the advantages of the crew module method of escape, read "The Near Ultimate in Escape Systems."

And, at last, we come to Facts and Figures and the 111 Logistic Field Directory. Without them, the November 111 LOG would be incomplete.
CONTRACTOR
FIELD SUPPORT
Wherever there is a requirement for contractor assistance to support a 111 program function, Fort Worth division Field Support personnel will be found on the job.

Fort Worth division Field Support personnel are presently assigned at customer test sites, training sites, operational bases (both in the United States and overseas), depot maintenance facilities, and at Air Force/Air Command headquarters. Because Fort Worth division Field Support personnel are limited in number by location, yet have virtually unlimited backup support from the home office, it is the intention of this article to depict the entire function of the Fort Worth division Field Support section.

**NEED FOR FIELD SUPPORT**

The introduction into the USAF and RAAF inventory of new and complex weapons, equipment, and systems with special operational capabilities and peculiar technical characteristics requires the transmittal of technical know-how from the producer to the using agency personnel. The Air Force provides this technical support to the using agency under the authority of AFR 66-18, and in accordance with the management and control procedures of AFM 66-18. The continuation of technical support and communication between the producer and using agency is required by the Air Force until using agency personnel become capable of maintaining and operating the systems and equipment.

Introduction of the 111 Weapons System into the Air Force inventory resulted in requirements for the Fort Worth division of General Dynamics Corporation to provide Contractor Engineering and Technical Services (CETS) to affected Air Force using agencies. The Field Support section of the 111 Logistic Support department is the primary element of the Fort Worth division to satisfy Air Force requirements for CETS. It is the intent and objective of the Field Support section to provide the Air Force with the very best CETS personnel in the industry, and to provide the most comprehensive “home-office” backup support possible.

Although field assignment duties among CETS personnel differ somewhat by function, the background qualifications established by Field Support management are the same for all; only pre-field assignment training differs, as explained in the following text. These qualifications and training requirements equal or surpass those specified by the Air Force.

**WHERE DO THEY COME FROM?**

Personnel selected for 111 CETS assignments are primarily those who have held similar positions in other programs or are persons from engineering with specialized capabilities. Also included are college graduates who undergo extensive training with the hardware and USAF standard operating procedures prior to field assignments.

Then there are those who were in the service early in life, returned to school upon discharge, finished their education, and were then employed as men of professions, but found that they missed service life (freedom of industrial traffic, time clocks, and drafting boards) and would like to be more closely associated with the service once more. There are other motivations, but in each case, CETS personnel are dedicated men, and have proved that they “fit the job” before being given a field assignment.

**111 CETS QUALIFICATIONS**

As stated in the foregoing, the qualifications for 111 CETS equal or surpass those specified by the Air Force. In addition to those routine industrial/government qualifications required for professional positions with the company (involving security, health, moral integrity, and the like), CETS candidates must have an educational background of at least a B.S., B.A., or the equivalent thereof. Beyond those qualifications, they must also have a personality adaptable to the position, and demonstrate a true desire for the type of work involved.

One may think the qualifications cited above are sufficient, but they are merely background qualifications. Equally important is for the CETS candidate to possess the ability to convey knowledge. He must prove he is capable of teaching, both in the classroom and on-the-job before he is acceptable to Field Support management for assignment to a customer facility.

**111 CETS TRAINING**

The training program established by Field Support management for “candidate” CETS consists of three main elements: formal classroom training, on-the-job training, and instructor training both in the classroom and on-the-job. Among 111 CETS candidates are those who are scheduled for extensive formal classroom training limited to courses concerned with special operational capabilities and peculiar technical characteristics of the end article(s) for which they are selected to cover. For example, a 111 airplane general (APG) CETS
THE FIRST CADRE of 111 Systems Instructors was formed over four years ago to conduct in-plant systems classes and all of the Air Force Staff Management classes. The instructors were experienced field support and maintenance engineering personnel.

AIR FORCE STAFF FAMILIARIZATION briefings are part of the 111 Field Support Customer indoctrination program. This CETS instructor uses a training aid model of the F-111A for aircraft orientation and component location, the specific subject being the environmental control system.

MODERN FACILITIES like this educational TV classroom in Fort Worth help provide the proper learning atmosphere for CETS personnel who are in training.

FIELD SUPPORT CETS "CANDIDATES" undergo rigorous study, testing, and on-the-job training before becoming full-fledged representatives for General Dynamics. Small classes encourage daily group discussions and personal inspection of training aids.
SPECIALIZED COURSES demand undivided concentration from apprentice CETS personnel. By the end of their formal training these men are specialists on the 111.

THE DC POWER PANEL in the forward equipment bay gets attention from 111 Field Support specialist and Air Force personnel. CETS personnel in the field not only give advice and demonstrations, but serve as instructors for classes.

CETS PERSONNEL discuss the 111 lower UHF antenna with SAC and TAC representatives. Although the photo was taken in Fort Worth at a flight line run station, it typifies technical liaison in the field.

WHEN AN AIRCRAFT starts showing signs of not living up to its flight potential, CETS personnel figure out the reason why and a possible solution. Here, two of our CETS men prepare to make a spike inspection on Ship 63 in Fort Worth to simulate “trouble-shooting” in the field for our camera.
A CALIFORNIA-BASED CETS representative gives 111 maintenance pointers to TAC technicians at Edwards Air Force Base.

LOGISTICS PERSONNEL headed for Takhi Royal Thai Air Force Base chat good-naturedly before boarding a C-141 at Nellis AFB. Here, the former contract services manager (far right) waits with some of the Air Force and support personnel.

HERE, ANOTHER GETS EMPLOYEE advises Edwards AFB personnel about cockpit seating aboard the F-111A.

A QJARTET OF TAC MAINTENANCE MEN surround this Edwards Air Force Base CETS representative for more information about the 111 leading edge slat.
candidate will receive intensive formal classroom training at the factory on the airframe structure, structural repair, airplane basic systems (landing gear, mechanical flight controls, fuel, hydraulics, pneumatics, electrical, environmental control, and so forth), and the use of related AGE; he will also receive less extensive classroom training (thorough familiarization) on the electronic subsystem and related AGE of the particular Mission/Design Number/Series (MDS) he is to cover.

Subsequent to commencement of formal classroom training, the APG CETS candidate is exposed to the hardware, and given on-the-job training by Maintenance Engineers and more advanced CETS candidates. This training is accomplished at the factory on the flight line and in maintenance shops, using the same technical publications and AGE that customer personnel utilize. This mixture of classroom and on-the-job training continues until the candidate has completed all classroom courses; he is then considered an APG CETS trainee, working on-the-job in support of the manufacturing effort. It is in this capacity that the candidate is subjected to the “acid test;” he has to teach new-hire manufacturing personnel. It is at this point that Field Support supervision decides whether to send the man to the customer or retain him in-house for backup support duty.

The training example cited above was for an APG CETS trainee; however, the same scheme is applicable to other type CETS trainees such as airborne avionic subsystem specialists and complex AGE test station specialists.

CETS training for candidates who are to serve as liaison at Air Force headquarters, provide prime AMA support, etc., is different in that there is no concentration of training on a specific end item. Rather, they receive thorough familiarization courses on all 111 program end items involved with their field assignments. In addition, he receives special training on customer operational planning, scheduling, and general program support requirements of the present and future, and his training is more tailored to fill a specific site CETS requirement. In summary, his training is broader in perspective of logistic support, and more oriented to liaison service between the company and the Air Force agency to which he is assigned.
FIELD ASSIGNMENTS

To allow for time spent in training, field assignments are tentatively made by Field Support supervision long before receipt of formal request and authorization from the Air Force. After his assignment, duties of the CETS individual are many, but his primary responsibility is to assist Air Force using agency personnel to learn proper techniques associated with operation, maintenance, and inspection of the end item(s) for which he was contracted to support. Of course, the method by which he accomplishes this responsibility is controlled by the commander, or a designated officer, of the Air Force activity to which it is assigned. To explain, the Director of Maintenance (DM) of a 111 Wing may feel that an APG CETS man could best train maintenance personnel under his command by continuous “over-the-shoulder” monitoring of flight line and shop activities, giving on-the-job personalized instruction to small groups (crew/shop chiefs and assistants). Ground handling incidents and repeated maintenance problems usually indicate needed classroom training for certain using agency personnel; in such cases the CETS man, working with the unit Training Officer, will accomplish formal classroom training necessary to correct the problems.

Other duties of CETS personnel, besides training customer personnel, include but are not limited to the following:

- Maintaining close coordination with the home office for technical and logistical backup support to his site
- Assisting using agency personnel in analyzing problems and component failures of 111 end items, and recommending corrective action therefore
- Preparing detailed reports for customer and company depicting problems and assisting in the preparation of customer reports (URs, EURs, and the like) as requested
- Participating in the investigation of accidents and incidents associated with 111 end items, as requested by appropriate customer authority
- Accomplishing expedited communication to the company for obtaining solutions to peculiar problems encountered on 111 end item components
- Coordinating, scheduling, and planning with appropriate customer personnel for contractor field crew accomplishment of TCTOs
- Maintaining accurate records of activities (reports written, classes taught, requests for information forwarded to the home office, etc.) and submit composite weekly reports of activities to the customer and company

The functional responsibilities of a CETS individual who is more of an “on-the-job advisor” to using agency supervision, coordinating with all elements of the Command (operational, maintenance, supply, training, and similar elements for example) differ from those of an APG CETS man. He is usually thought of by the using agency personnel with whom he works as “Mr. Contractor,” he has to wear many hats. Being spread so thin, he is not expected to know the technical aspects of a specific end item to the extent of the knowledge of the specialized and article CETS man. However, many do because they were the latter type first.

Normally, at each customer site where there are a number of Fort Worth division CETS personnel assigned, one of them is designated the Field Service Representative In-Charge (FSR-IC). The assignment is made by Fort Worth division Field Support management. This is desirable for general supervision of company personnel, but more important to facilitate an on-site centralized administrative function.

BACKUP SUPPORT

Backup support for Fort Worth division CETS personnel is provided through the Field Support section of the 111 Logistic Support department. This section is the “home office” referred to previously in this article; but it is merely the nucleus of contractor backup support. The section consists of a Chief of Field Support, necessary administrative personnel, supervision, and CETS candidates in training.
The Field Support section has in-house backup support of the entire division, but depends primarily on the Maintenance Engineering section of the 111 Logistic Support department for support. For example, Maintenance Engineering support includes formal technical training of CETS personnel (basic and updating), providing answers to all CETS and customer requests for technical information, and accomplishment of in-house planning and coordination for contractor field modification tasks.

The Maintenance Engineer is backed up by his counterparts in other division segments such as design engineering, quality control, manufacturing, and so forth. Thus, the home office has ample assistance in backup support for CETS personnel assigned to customer facilities.

To expedite transmission of problem-solving information to CETS personnel in the field, General Dynamics has recently established an information-exchange center at the Fort Worth division, known as the Logistic Support Communications and Status Center. The Center consists of a “Strongroom” located in the new Engineering and Office Building. The Center operates seven days a week and 24 hours a day to accommodate the time differential from remote customer sites.

Commercial equipment presently installed in the Communications and Status Center includes TELEX and TWX receivers, recording capabilities for incoming conversations, and telecon conference speakers. Future plans for the Center include the installation of the AUTOVON network (an existing government communications system). The AUTOVON would be to the advantage of both customer and contractor for receiving and transmitting urgent information. Of course, the AUTOVON would be utilized in accordance with applicable Air Force regulations and directives governing priorities pertaining to the weapons system.

***

It is the intent of this article to give the reader a better understanding of the whys and wherefores of the Fort Worth division’s participation in field support for the 111 program. It should be pointed out, however, that the article only depicts the contractor’s field support efforts required during the introductory phase of the 111 weapons system. As each 111 Mission/Design Number/Series becomes fully operational in the Air Force inventory, requirements for contractor field support will diminish accordingly. The sooner 111 personnel accomplish their missions as CETS, the higher the tribute to them and the Fort Worth division for a job well done, and to the using agencies for their proficiency.

WHEN IT HAPPENS

Prepared by Clyde Cushman, Division Aerospace Safety, General Dynamics Fort Worth Division

Each year General Dynamics and the customers spend quite a basket full of funds on accident prevention. The rewards of this investment are great but difficult to define. Occasionally, the joint efforts in the accident prevention field fail or fall short of their goal and we end up with a problem. When this occurs, the combined efforts of our customer and ourselves are geared to aid in every way towards reaching a solution. Here’s an example:

“Pebble Air Force Base, this is Roscoe 84. On climb out we just experienced an unusual noise in the nose gear area during retraction. I don’t believe it’s locked up – extending now.”

“Roscoe 84 – Pebble confirming you have an unusual noise in nose gear area. Have you extended gear?”

“Pebble-84 – affirmative. Gear is extended and now – uh – a safe indication was acquired for both main gears, but now the nose gear indicates unsafe. I’m presently about 15 miles out and I’m making a one eighty to stay in local area. Request instructions.”
As 111 program production requirements became known, it was obvious that changes were necessary in both facilities and methods if schedules were to be met. More and also different machinery, other equipment, and new sized materials were required; likewise, administration, design, and testing, in addition to production, required more people in more office space than ever before. It was necessary to station these people in many former warehouse and factory areas to start the 111 programs; now, however, these employees have been moved into new quarters, providing more room for machinery, warehouse equipment, and storage space necessary to support the rate of production scheduled for the several versions of 111 aircraft.

The manufacture of one airplane requires handling approximately 225,000 pounds of raw material; equipment and office supplies are required for thousands of employees. All of this must — in some fashion — pass in and out of warehousing facilities.

Through this building program, the Fort Worth division now has modernized areas for handling, distributing, and storing. New equipment, in keeping with technological advances, permits rapid movement throughout receiving, shipping, and storage from a distribution area strategically located near the start of production flow.

The new facility has made possible the necessary improvements for production of the 111 aircraft. This modern, well-conceived material handling setup was developed to take full advantage of the latest types of equipment. The building was designed around such equipment to ensure realization of its fullest potential. Unique building design features include the use of supporting columns for both building and overhead cranes, standard lighting supplemented by mercury vapor lamps, and overhead strip heaters.

**RECEIVING**

The most critical factor in the successful implementation of any logistics operation is the capa-

A study of the total division needs resulted in a 588,000-square foot expansion of the warehousing facility at Fort Worth division. The total warehouse area now consists of more 1,000,000 square feet.

AFTER BEING OPENED AND INSPECTED, large and small containers are loaded on dollies and are either stored or routed direct to the using departments.

bility to move material and supplies efficiently in a short period of time. The Fort Worth division was faced with this problem in production planning for the various 111 types. The total division facility study made at the beginning of 111 production
showed that the warehousing along the west side of the main building had outgrown its effectiveness. An acceptable material support plan demanded more advanced equipment and a layout that would permit more expeditious handling of all incoming material. This material had to be located near the point of use to reduce subsequent movement and transportation.

With this in mind, the new warehouse building was designed for construction at the south or initial fabrication end of the production building. The movement of incoming rail cars and trucks is confined to a relatively small area, which decreases travel on the plant site and helps to minimize security problems.

The new warehouse design incorporates the latest mechanical devices for handling all types of material arriving and departing by either rail cars or trucks. The truck transport receiving and shipping docks are equipped with automatic leveling ramps that provide easy access to loading and unloading all types of vehicles. The railroad and truck transport shipping and receiving docks are under roof which allows for all-weather loading and unloading. The new warehouse is designed to permit expansion, should the need arise in the future, with little interference to either the manufacturing or warehousing operations.

**STORAGE**

Completion of the new warehousing gives the Fort Worth division an effective way of handling all incoming and outgoing material. The areas outside the main factory building are used to locate material and supplies near their usage point. In addition, new outdoor tooling storage pad area was constructed for storage of large tooling when not in use. Only the tools that will not be affected by the weather are stored in this area.

Automobile fuel, aircraft fuel, liquid oxygen, ammunition, paint, chemicals, and solvents are all stored in separate areas outside the main building and as near to the point of use as possible. Storing explosive, toxic, or flammable material separately in areas that can be contained is a primary part of the division storage plan.

The outside production items such as aerospace ground equipment, complete aircraft components like the aft fuselage assembly, horizontal stabilizer, jet engine assembly, and landing gear assembly are stored on the west side near the center of the factory before being routed into production or subassembly buildup areas.

**DISTRIBUTION**

Stacker cranes, bridge cranes, and trams are used to transfer the raw materials which must be retained in the warehouse. Raw material issue includes interim storage if the material goes through the first-cut operation. The factory area has provisions for on-location storage of much material that has been processed through the first cut. This arrangement minimizes handling, stacking, and storage.

The use of existing trams, tow motors, and monorails will continue to transfer and move raw material and general material throughout the factory and flight line areas.

In the new warehouse materials are towed by one of three driverless tractors to their proper locations for storing. This driverless train system provides an efficient flow in the general warehouse from receiving to material issued as well as alternate routes that may be selected. The tractors are standard battery-powered, electronically controlled, tow tractors and have a capacity for towing
six, fully-loaded, 4000-pound industrial trams at a speed of 3.4 miles per hour. Each tractor has two safety features: one is a sonar scope that scans the towpath and starts slowing the tractor when it comes within 15 feet of an object and stops the tractor when it gets within 7 feet of the object, the second safety feature is a wrap-around bumper that stops the tractor when an object comes in contact with it.

The magnetic guidance for the driverless train systems consists of a low-frequency guide wire placed in a shallow groove in the floor. Steering is done by electronic controls that sense the relation of the tractor steerable wheels to the guide wire in the floor. The controls sense and follow the towpath, steering automatically to keep the wheels centered on the towpath. This system has 3500 feet of guide wire over a towpath that has 12 programmed stops and one permanent stop. Each tractor can be programmed to stop at one or all of the stops.

**SHIPPING**

This assembly area has been designed for handling railroad or truck transport shipping, and serves as the outgoing area from the plant.

Material to be shipped out of the division is sent to the shipping area and placed on conveyor lines through the various stages of packaging, crating, and securing for shipment. Material is inspected for quality, quantity, and compliance with regulations.

If materials need to be shipped out of the division from other areas of the plant, the requests to do so are still processed through this area. This may be done when the material is unusually large and multiple handling is impractical.

The most modern equipment is used to replace manual packaging, thus reducing costs while increasing production. A bagging machine that uses transparent, thin-gauge polyethylene is used to package small spares items. The bags are fabricated
IN THE NEW WAREHOUSE materials are towed by one of three driverless tractors to their proper locations for storing. This "driverless train system" provides an efficient flow from receiving to distribution.

SPARES PACKAGING is achieved via modern equipment—reducing costs while increasing production. Preparation for shipment of spares is handled in the shipping area, adjacent to the raw material warehouse.
and sealed automatically. This operation replaced the prefabricated, hand-stenciled bags that were formerly used. Another machine makes a rigid polyurethane foam that secures irregular-shaped items in shipping containers. The corrugated fiberboard box operation is equipped to make boxes from single wall, bi-wall, and tri-wall material.

The paperwork for shipping spares has been reduced to one computer card for each spares item. Under the previous system, up to five forms for each spares item were required.

**ADMINISTRATION**

To minimize communication and in-plant travel problems and to provide on-the-spot coverage of all receiving, warehousing, and shipping functions, three administrative areas have been included movement of all materials and supplies to the factory area.

The receiving office is located in the southwest corner of the facility as conveniently as possible near the receiving docks. Purchase orders, packing slips, and other types of purchase data are processed in this office from paperwork routed from the receiving floor via an automatic paper conveyor.

An inspection test laboratory is located in the southeast corner of the general warehouse. One of the prime functions of personnel in this area is the functional testing of parts and/or subsystem components received from suppliers participating in the 111 programs. The various types of equipment necessary to perform the functional tests, as required by subcontract and military specifications are housed in this area.

THE PAPERWORK FOR SHIPPING SPARES has been reduced to one computer card for each spares item. The spares allocation function is handled in the shipping area of the warehouse.

within the warehouse complex. All warehouse operations are governed from the central office, which is centrally located within the new facility. This office provides space for supervisory and clerical personnel, including transportation administrative services. All requisitions are processed through the central office which controls the

There are many forms of logistics. The foregoing, which deals with the receipt, storage, distribution, and shipment of material, is only a part of the logistics of an industrial manufacturing complex such as General Dynamics, a company which continuously strives to increase efficiency and decrease cost in an era of intense competition.
that for years there has been a large selection of wind chill diagrams from which to choose?

Wind chill indices, wind chill factors, wind chill factor indices, chill indices, and nomograms of dry-shade atmospheric cooling are all examples of the diversity available in this area. Some bases even have had different wind chill charts for the different units operating there. The large number of graphs and indices has led to a great deal of confusion as to just exactly what WIND CHILL means. The 111 LOG made its contribution to the confusion in the November 1967 issue when it reprinted one of those charts.
### Equivalent Chill Temperature Chart

AWS Regulation No. 105-9, dated 17 July 1968, was issued by the Air Weather Service (AWS) and recently came to our attention. It contains a chart, **Equivalent Chill Temperature**, which will be used by all AWS units in place of all other types of wind chill charts. No other charts are authorized except those that are identical (ALCOM form 13 or NORAD form 12, for example). This particular chart and identical ones are based on a study initiated by the Arctic Aeromedical Lab.

Cold weather is just around the corner again for most of us. Therefore, in an effort to remove the confusion, the 111 LOG is reproducing the AWS Temperature Equivalent Chill chart for use by interested parties who may not already be familiar with it.

To use the chart, measure local temperature and wind velocity if possible; if not, estimate. Enter the table at the closest 5°F interval along the top and with appropriate wind speed along the left side. Their intersection gives the approximate equivalent chill temperature; that is, the temperature that would cause the same rate of cooling under calm conditions. For example, an actual temperature of 0°F will affect your body as a chill temperature of -5°F if the wind is 5 mph; but if the wind increases to 25 mph (temperature the same), the chill temperature will be -45°F. Note that the table was constructed using miles per hour; however, a scale
giving the equivalent range in knots has been included on the chart to facilitate its use with either unit.

The WIND portion of wind chill can be air motion from any cause. It is the rate of relative air movement past a body that counts. Wind caused by a body’s motion through the air will lower the equivalent temperature just as rapidly as natural wind past the body. Walking, riding in open vehicles, standing in helicopter rotor or propeller wash, and skiing are some examples of activities that will cause air motion past your body. The speed of movement, in addition to natural wind, must be considered when using a wind chill chart.

The effect of the wind will be less if you have even slight protection for exposed parts such as light gloves, a parka hood shielding your face, or so forth. Also you are better off if you are active. A man produces approximately 341 BTUs of heat standing still but up to 3413 BTUs in vigorous activity like cross-country skiing.

There is no substitute for common sense. The chart serves only as a guide to the cooling effect of the wind on bare flesh when first exposed. General body cooling, amount of clothing, diet, and many other factors affect the risk of freezing injury.

FACTS AND FIGURES

AS OF 28 OCTOBER 1968

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“Necessity is the mother of invention.” So runs an old adage that very aptly describes the development of airplane escape systems. And “necessity,” in this case involves survival of aircrews, who are the brains of a stricken metal creature, that must be saved for transplanting into another metal creature to give it life and the ability to fly. Also, “necessity” is the psychological assurance that there is an avenue of escape if needed, which builds needed confidence in the men who fly.
A quick glance at aviation history shows that complexity of escape systems has been the natural result of the increase in airplane performance capability. Significant events in this history are:

1793  François Blanchard made successful use of the parachute in jumping from a balloon.

1908  First manually operated parachute invented by Leo Stevens.

1923  Wearing of parachutes made mandatory on all Army Air Corps flights.

1945  German and British in-flight use of ejection seat.

1946  USAF ejection from P-61B aircraft.

1962  Escape capsule in-flight ejection from B-58.

1967  F-111 crew module in-flight ejection.

Just what is the significance of this step from open ejection seat to crew escape module? The crew module shares many basic features of the ejection seat, but vastly improves all these aspects as well as adding several unique capabilities. If an escape system can really be called "advanced," that would certainly apply to the 111 crew module.

The purpose of an escape system from the designer's viewpoint is threefold. First, he seeks to provide safe escape from the aircraft in flight, on the ground, and under water. Second, he recognizes the need for post landing survival capability. Third, the escape system should cause minimum degradation to crew station efficiency, that is, minimum personal equipment for the escape function, maximum console and instrument space, and full seat adjustment for comfort and maximum access to consoles. It is immediately apparent that ejection seats afford very poor compliance with these objectives, while the crew module concept scores very high.

Specifically, the advantages of the crew module over the ejection seat are as follows.
The capability of an ejection seat to recover a man safely from a high speed ejection is restricted by human tolerance to the physiological forces experienced during the ejection sequence. A seat can easily be built to withstand the blast and ejection forces. But exposure of the human body to windblast can result in crushing injuries to the chest and injurious flailing of the arms, legs, and head. Low altitude ejections in the open seat are presently restricted to less than 450 knots, which is the threshold of injury. The threshold of fatality occurs at about 600 knots. Since crew module occupants are protected from windblast, the only ejection speed restriction becomes the structural capacity of the vehicle and the capability of the man to withstand the controlled deceleration forces.

Environmental exposure of the open seat occupant also includes the low pressures of a high altitude ejection. The upper limit of low pressure exposure if oxygen is provided is about 40,000 feet without a pressure suit. The ceiling on prolonged human survival capability without oxygen is 18,000 feet. The crew module provides complete environmental protection at all operational altitudes.

Stabilized flight is a major problem in escape systems. During the escape sequence, ejection seats tend to tumble because of their lack of streamlining and few devices for controlled stabilization and deceleration. This results in excessive forces on the occupant and interfaces with seat-man separation and parachute deployment. The crew module concept, on the other hand, allows for solution of these instability problems. Wind tunnel and sled tests have proved out the aerodynamic suitability of the crew module's shape and stabilization devices. With careful control of center of gravity, stabilized flight is assured.

The only conscious act required in a successful escape and recovery cycle in the crew module is actuation of either of two ejection handles by either crew member. From that instance through touchdown the escape sequence is automatic, even if both occupants were to lose consciousness. Such capability is very difficult to build into the limited volume of an ejection seat. If at some point in the escape sequence of an ejection seat the crew member loses consciousness, some vital link in the survival chain may be broken.

Complete environmental protection afforded by the crew module may be summed up as protection from windblast, decompression, loss of helmet or oxygen mask, bodily injuries from impact with irregularities on the ground surface, lack of impact force attenuation, drowning, and temperature extremes. Complete environmental protection also includes a means of escape from an airplane afire on the ground and a means of ejecting the crew members to an area beyond that of the heat, flames, and possible explosion. In addition, the side-by-side seating arrangement in the crew module affords the unique opportunity for mutual assistance and the assurance of companionship that the lone ejection seat occupant must forego.

Loss of survival equipment is one of the possibilities during escape by means of an ejection seat. Prior to rescue, the downed flyer must possess the equipment necessary to meet the three basic survival needs: water, body temperature, and a means of signaling rescue teams. The crew module provides a large volume for stowage and security of a great quantity and variety of survival aids without the possibility of their becoming separated from the potential users.

After descent to desert, forest, mountains, tundra, ocean, or island the usefulness of the ejection seat is finished. Not so with the crew module. It is a ready-made, insulated shelter on land or a sheltered, sea-worthy vessel on the water, continuing its job of protecting the occupants right up to the point of rescue. Furthermore, if retrieval of the crew module is possible, the entire cabin area of the airplane with its valuable equipment is available for salvage.

The foregoing discussion has dealt with the crew module's capability for maximum protection of crew members. Also worthy of consideration is the aspect of minimum restraint on the crew members during normal flight activities. Ejection seats always have a significant impact upon crew comfort, equipment access, and available space for cabin components. The crew module features "shirt-sleeve" flying without cumbersome parachutes, survival equipment and protective clothing worn by the flight crews. The crew module escape system manual controls have a minimum impact upon crew station arrangement. Flexibility of seat adjustment enhances crew comfort and equipment access, which is greatly degraded when bulky ejection seats must be fitted into an already tight airplane cabin.

Thus it can be seen that the 111 crew module is a truly unique escape system, the culmination of the evolutionary development of escape systems. Hence, the 111 airplane will merit its niche in aviation history primarily because of its variable sweep wing and secondarily because of its unique escape system — two outstanding firsts for an outstanding airplane.
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