DESIGN A SOFTWARE FOR METEOROLOGICAL OBSERVATIONS

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by

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İZMİR

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We certify that we have read the thesis, entitled **"Design a Software for Meteorological Observations"** completed by Ferkan KAPLANSEREN under supervision of Prof. Dr. Tatyana YAKHNO and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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I have been working at İzmir Meteorological Service for 8 years as an observer. I remember how observers were happy when they begun to use MIVIP to code their observations instead of coding manually. By the passing years, with the improving of the computer technology in human being life, also observers wished to use better coding systems for their observations. When I decided to prepare a project about coding system, I would not think such an interest to my project from my observer friends. Now, I am really proud of designing such a system helping my friends.

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To my brother Seren.

ABSTRACT

There are a lot of meteorological stations that are members of World Meteorological Organization (WMO) observing the weather to become successful at weather forecasting or any statistical research related to meteorological parameters over the whole world. Because of observations being the basis duty for any meteorological investment all meteorological stations do different type of observation according to their geographical place and to their technological equipment.

There are different types of observations that are done at land meteorological stations. Some of them are synoptic, climatologic, marine, radiosonde and rainfall observations. Different meteorological stations are responsible for different observations. Some of them have to do synoptic observations while others have to do marine or climatologic or both marine and synoptic observations. The two important observation types are the synoptic observation, which is done every hour in a day, and the marine observation, which is done 7 times a day.

These meteorological stations doing the synoptic and marine observations have to obey some rules of WMO to have an agreement on the same type of observations. An observation is basically defined as recording the values of the meteorological parameters such as wind, temperature, pressure, and humidity at determined times. These observations are done automatically by the instruments having the sensors of the meteorological parameters, or done manually from the meteorological instruments. At the end of recording these observation values, one important duty is coding them in a standard form. These observations are coded automatically by an

observation coding system as well as they are coded manually. An observer must know what kind of observation he or she has to do. The first aim of an observer after observing weather should be to code the values collected from meteorological instruments and from the sky.

There are standard code techniques of WMO for all meteorologists to code the observations. FERO-1 is a kind of observation coding system, which is improved by Ferkan KAPLANSEREN in 2000-2001 for the meteorological synoptic and marine observations that are prepared on land meteorological stations at determined times to match the standards of WMO. FERO-1 is designed to give alternative opportunities for fast and correct coding to observers working at the meteorological stations in Turkey.

An information system for meteorology is formally defined as a collection of data, records or elements of meteorological parameters and the means of obtaining, organizing, retrieving or otherwise processing the data for use. For that reason FERO-1 is designed as an information system, which collects the data, manages the data and by processing data, prepares codes for the synoptic and marine observations. FERO-1 is especially designed for meteorological stations in Turkey; also matching the standards of WMO any station over the world dealing with synoptic observation can use it.

During the design time, observers working at Izmir Meteorological Service were consulted about the requirements on the system. Meteorological information is supplied from the meteorological station library and from the observers. The standards of synoptic and marine observation and coding techniques of them declared by WMO are analysed carefully and were applied on users requirements. Other systems studied to understand their advantages and disadvantages for users.

For the software part of the design, Borland Delphi 5 Programming Language and Microsoft Access were used. Borland Delphi is used for easy visual implementation for programmer and easy usage of the program for users. Microsoft Access is used for the database of the system. Almost every meteorological station has windows operating system on their computers and most of the observers are familiar with this system. So, because of FERO-1 working on the windows operating system, users get no big difficulty to use it.

The need of FERO-1 is thought because of users finding the other systems insufficient and having old technologies for their requests. So, the observation coding part of the systems such as MIVIP (Meteorolojik Veri Iletisim Paketi (Meteorological data Communication Package)) and TURK METCAP (Turkish Meteorological Communication and Application Package) are studied to get the dissatisfactions of users, not to repeat these insufficient subjects at FERO-1. Users have met a database, some searching procedures, easy usage and a quality control mechanism at this new system. These are really new opportunities for Turkish observers. FERO-1 gives some other abilities to users to operate the collected data. At the same time the experimental results have shown that it matches most of requirements of users.

Because FERO-1 works under Windows operating system users begun to use the mouse and can rich to the menus just clicking the recommended buttons. The automatic prepared forms are so easy for users to fill and forms never imply unnecessary blanks about unneeded meteorological parameter for that observation. The combo boxes don't allow user to fill a different value, which is not appropriated to that parameter. So entering wrong values into database and coding wrong observations are prevented. The calculations and some searches, which are made at the end of the day, are also made by FERO-1 automatically. FER0-1 finds the maximum and the minimum values of temperature, pressure, humidity, wind-speed and water vapor pressure and for the last day.

FERO-1 prepares the suitable forms for each observation time, does not allow user prepare wrong type of observation, makes the quality control to entered values, keeps the meteorological data in database, lets user search the database, prepares the different codes of observations such as synoptic, marine, marine explanation in Turkish, maximum and minimum, lets user do not enter the same values repeatedly for different observations at the same time, calculates the mean sea level pressure, humidity, water vapor pressure and dew point degree at different forms and finds the extreme values of the day.

ÖZET

Dünya Meteoroloji Teşkilatı'na (DMO) bağlı çok sayıda meteoroloji istasyonu, hava tahmininde veya meteorolojik parametrelere dayalı istatistiksel çalışmalarda başarılı olabilmek için havayı gözlerler. Meteorolojik çalışmaların temelini rasatlar oluşturduğu için, meteorolojik istasyonlar coğrafik konumlarına ve teknolojik donanımlarına bağlı olarak farklı rasatlar yaparlar.

Kara meteoroloji istasyonlarında farklı rasatlar yapılmaktadır. Bunların bazıları sinoptik, klima, deniz, radiosonde, ve yağış rasatlarıdır. Farklı meteoroloji istasyonları farklı rasatlardan sorumludurlar. Bazıları klima, deniz veya sinoptik ile deniz rasatlarını birlikte yapmak zorundayken, bazıları ise sadece sinoptik rasat yapmakla sorumludur. İki önemli rasat çeşidinden birisi günün her saati yapılan sinoptik rasat ve bir diğeri de günde 7 defa yapılan deniz rasadıdır.

Sinoptik ve deniz rasatlarını yapan meteoroloji istasyonları, aynı rasatlar için anlaşma hususunda DMO'nun bazı kurallarına uymak zorundadırlar. Bir rasat kısaca; rüzgar, sıcaklık, basınç ve nem gibi bazı meteorolojik parametrelerin belli zamanlarda kaydedilmesidir. Bu kayıtlar bir sensör tarafından otomatik olarak yapıldığı gibi, manuel olarak meteorolojik aletlerden de yapılabilir. Rasat değerlerinin kaydedilmesinden sonra bir önemli işte bu değerlerin standart bir formda kodlanmasıdır. Bu kodlama işlemi manuel olarak yapılabildiği gibi bir rasat kodlama sistemi tarafından otomatik olarak da yapılabilir. Bir rasatçı hangi rasadın hangi saate yapıldığını bilmek zorundadır. Bu rasatçının rasadını yaptıktan sonra ilk amacı bu rasadı kodlamak olacaktır.

Bütün rasatçılar için, rasatları kodlayabilmeleri hususunda DMO'nun belirlediği standart kod teknikleri vardır. FERO-1, DMO standartlarını karşılamak

için belirlenmiş zamanlarda kara meteoroloji istasyonlarında yapılan sinoptik ve deniz rasatları için Ferkan KAPLANSEREN tarafindan 2000-2001 yılları arasında geliştirilmiş bir rasat kodlama sistemidir. FERO-1, Türkiye'deki meteoroloji istasyonlarında çalışan rasatçılara hızlı ve doğru kodlama için alternatif fırsatlar vermek için dizayn edilmiştir.

Bir meteoroloji bilgi sistemi, meteorolojik parametrelerin kayıtları veya elementleri anlamına gelen verilerin toplamasını, kazanılmasını, ulaşılmasını veya bu verilerin kullanılması için işlenmesini sağlayan yapıdır. Bu sebeple FERO-1 de verilerin toplanmasını, düzenlenmesini ve bu verileri işleyerek sinoptik ve deniz rasatları için kodların hazırlanmasını sağlayan bir bilgi sistemi gibi düşünülmüştür. FERO-1 özellikle Türkiye'deki meteoroloji istasyonları için geliştirilmesi yanı sıra, DMO standartlarını karşıladığı için, sinoptik rasat ile uğraşan dünyadaki herhangi bir meteoroloji istasyonunda da kullanılabilir.

Dizayn süresi boyunca, İzmir meteoroloji servisindeki rasatçıların ihtiyaçları öğrenildi. Meteorolojik bilgiler, meteorolojinin kütüphanesinden ve rasatçılardan sağlandı. DMO tarafindan açıklanan sinoptik ve deniz rasatları ve bu rasatların kodlanma teknikleri analiz edilerek kullanıcı ihtiyaçları üzerinde uygulandı. Diğer sistemlerin avantaj ve dezavantajları öğrenildi.

Programın yazılım kısmında Borland Delphi 5 programlama dili ve Microsoft Access kullanıldı. Borland Delphi 5, programcı açısından rahat görsel implemantasyon imkanı sağladığı için, kullanıcı açısından ise kullanımı rahat olduğu için kullanıldı. Microsoft Access, sisteminin veri tabanı kısmı için kullanıldı. Meteoroloji istasyonlarının çoğunda, Windows işletim sistemine sahip bilgisayarlar mevcuttur. FERO-1'de Windows işletim sistemi altında çalıştığı için rasatçılar FERO-1'i kullanırken fazla zorlanmazlar.

FERO-1 ihtiyacı, rasatçıların diğer sistemleri yetersiz ve eski teknolojilere sahip sistemler olarak görmelerinden dolayı doğmuştur. MIVIP (Meteorolojik Veri İletişim Paketi) ve METCAP (Meteorological Data Communication

Package) gibi sistemlerin rasat kodlama sistemleri, kullanıcıların şikayetlerini anlamak ve aynı şikayetlere sebebiyet vermemek için çalışıldı. Kullanıcılar bu yeni sistemde, bir veri tabanı, bazı arama prosedürleri, kolay kullanım ve kalite kontrol mekanizması ile tanıştılar. FERO-1 kullanıcılara, toplanan veri üzerinde işlem yapma imkanı verir. FERO-1'in deneme süresi boyunca kullanıcıların isteklerini karşıladığı görülmüştür.

FERO-1, windows işletim sistemi altında çalıştığı için kullanıcılar fareyi kullanarak menülere ulaşabilirler. Otomatik hazırlanan formlar, kullanıcıya bu formları rahat doldurma imkanı verir. Formlar gereksiz doldurmalara imkan vermeyecek ve bazı değerlerin kombo kutularından seçilmesini zorlayacak şekilde hazırlanmıştır. Böylece veri tabanına yanlış bilgilerin girilmesi ve rasatların yanlış kodlanması engellenmiştir. Gün sonunda yapılan bazı hesaplamalar ve arama işlemleri, FERO-1 tarafindan otomatik olarak yapılır. FERO-1, son günün, sıcaklık, basınç, nem, rüzgar hızı ve su buhar basıncına ait azami ve asgari değerleri hesaplar.

FERO-1 her rasat saati için uygun formu hazırladığı için kullanıcının yanlış kodlama yapmasını engeller, girilen değerlere kalite kontrol yapar, meteorolojik veriyi veri tabanında tutar, kullanıcıya veri tabanını arama imkanı verir, sinoptik, deniz, Türkçe açıklamalı deniz, azami sıcaklık ve asgari sıcaklık rasatları gibi farklı rasatları hazırlar, kullanıcının aynı saatteki farklı rasatlar için, değerlerin tekrar girmesini engeller, deniz seviyesi basıncını, nemi, su buhar basıncını ve işba sıcaklığını farklı formlarda hesaplar ve günün ekstrem değerlerini bulur.

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CHAPTER ONE
INTRODUCTION

In general, an information system for meteorology is formally defined as a collection of data, records or elements of meteorological parameters and the means of obtaining, organizing, retrieving or otherwise processing the data for use. So a meteorological information system will therefore involve all the processes, from the time the observational data is fed into the system till the data and derived products are available for use by the observers, forecasters or any other programs. In WMO (World Meteorological Organization) terms, it includes the Observation system, the Data Management system, the Data Processing system and the communication systems that provide the communication vehicle for the data and products. What is needed to make it a proper information system is a single entry point into the data and information of these systems.

The World Weather Watch (WWW) Information system can be defined as procedures and techniques to collect, distribute and make meteorological data and products available to the National Meteorological Services, all other WMO Programs and the broader environmental community.

Meteorological requirements of the system must be briefly defined to design a quality observation coding system. In broad terms a system is required that can make all meteorological data and products available to all observers in the required time and format. The system must be user friendly and easy to implement. The system must be reliable and not put a big cost burden on the users. The system must be flexible to adjust to changing requirements and be able to adapt to new, more cost effective technologies as it becomes available.

At Turkish State Meteorological Service, there are two important programs that are used to code observations. TURK METCAP and MIVIP are communication programs but at the same time both of them have an observation coding part. The observation coding part of the advanced one TURK METCAP is used for synoptic, metar and climatologic type of observations. The simple one MIVIP is used for synoptic, metar, marine and climatologic type of observations.

1.1 TURK METCAP

TURK METCAP (Turkish Meteorological Communication Package) is a communication program that lets meteorological stations get connection with the center meteorological service (Turkish State Meteorological Service (ANKARA)) and some other centers over the world. METCAP has general purpose about meteorological communication. It sends different type of information from observations to weather charts from the center meteorological to the outsiders meteorological services and vice versa.

DINAR, Kemal DOKUYUCU and Cemal OKTAR, design TURK METCAP for the Turkish meteorological Services. Before the last year, especially the stations at airports were using METCAP Program but now most of the stations in Turkey use it. While it was used at airports it has no observation coding system and is used just for communication but now it includes an observation coding system for synoptic, metar and climatological observations

METCAP Observation Coding Program runs as package under TURK METCAP. It is written with Pascal Programming Languages and it runs under MS DOS operating system. No quality control, no database and searching opportunity at coding part of METCAP. It codes the observation values directly from the entered values. If observer enters any wrong number, program produces wrong code for that observation. It is difficult to improve its software if any changes are needed.

There are one main menu and three sub menus in this program. To visit the sub menus F1, F2 and F4 buttons are used. To finish the program F7 button is used and to see which menu observer is at now there is message on the right top of the menu. The sub menus are station, editor and coding menu.

1.1.1 STATION MENU

If observer presses F1 button at main menu, station menu opens. The station Menu lets the observer to enter or change the information values about the Meteorological Station. Pressing F1 button opens the station information entrance form. It is recommended to choose F2 button to enter the station values instead of F1 button. F2 button opens the station information correction form. For correct calculations, user must fill this part of program correctly according to their station information and it is just done for one time. User comes over the numbers related to different information and presses enter to change that information. To get out from this menu user comes over number 18 and presses enter. To turn back to main menu button F7 is used.

1.1.2 CODING MENU

F4 button lets user visit the coding menu. F1, F2, F3 is appropriated for metar, synoptic and climatologic observation respectively. The Coding Menu is used to choose the observation type and to prepare codes. By pressing function buttons user can choose synoptic, metar or climatologic observations and begins to enter the observation values. If observer finishes the filling the values menu correctly, the program is ready to code the values and gives the prepared observation to you.

1.1.3 EDITOR MENU

F2 button makes observer visit the editor menu. Editor Menu is used to write observation codes manually or to get the old codes onto the screen to edit. User must obey some rules at editor menu such as beginning to write from the first column and first line. User should not use more than one space between the coded groups. If observer obeys these rules at the end of the coding there will be no writing error on the screen.

1.2 MIVIP

Meteorological Observation and communication program (MVIP) written by Bircan SARIKAYA is a program that provides the data communication between central meteorological centre and outsider meteorological stations. The communication is made by a dial-up modem by using phone lines. The coding part of MIVIP Program runs under MS DOS operating system and written with Pascal Programming Language by Omer KUCUKARSLAN. It is very simple program and usage is friendly for observers. It is run by a 3.5 diskette that contains all program. No improvement can be made because the source code of the program and the owners of them do not work at meteorology.

MIVIP contains 4 sub menus called rasat, istasyon, ikur and mivip. Rasat menu is reached from mivip menu so rasat menu is the shortest way to code the values. Ikur menu is a form containing the phone numbers of the central meteorological service. Istasyon menu lets observer edit or enter the station information. If you write mivip after A:\ prompt mivip menu opens.

1.2.1 MIVIP MENU

MIVIP menu has an editor and function buttons at the top of editor. F1 button is used to save the data into the disk but all data is deleted after turning of the computer. F4 button lets observers to see the saved data in the disk. F9 button sends the data to another station. F5 is the observation-coding button. After pressing this button there occurs a message asking if observer needs to change the observation time. Generally this question is answered by yes. Then there are four type of observation called main synoptic, synoptic, marine, metar and climatologic observations seem on the screen. Observer has to know which observation must be coded because, if observer chooses wrong observation type, observer is never warned by program. So observer certainly gets wrong code for the observation. Observer chooses one of them and begins to fill the observation form. After finishing the entering values observer turns back to editor end see the coded observation on the screen. User himself or herself controls the observation if it is correct or not. If there is a mistake user corrects the code.

Izmir Meteorological Service has been using MIVIP for eight years. Day by day users find it insufficient for their requirements. Four years ago WMO changed the third group (Actual Pressure Group) of the synoptic observations but MIVIP still puts this group into the code. Because, chancing the software of MIVIP is impossible. Observer must delete that group which is coded by the program. It is a very easy program to use but has no quality program to warn the users against the mistakes. So sometimes if you give just one wrong value to program, it can prepare no code for your observation

If an observer knows exactly everything about coding and MIVIP, usage of MIVIP is very friendly but if user makes any mistake it is possible to make the observation again. For that reason user loses too much time. Every month looking up to the observation coding mistakes reports that is sent by Central Meteorological Service to other meteorological stations, it can be said that users make most of the mistakes entering one digit wrongly. Even these simple mistakes cannot be corrected by MIVIP. Also for some observation times an observer must code synoptic and marine observations together and every time observer enters the same value firstly into synoptic observation menu and then into marine observation menu. This is also time loosing for observer and sometimes by using the same pressure value MIVIP codes different pressure groups for synoptic and marine observations.

Observers prefer MIVIP to METCAP for their observations. Because MIVIP is very easy to use and if you never enter wrong values, your observation is successfully coded except third group. MIVIP runs too slowly than METCAP because of its processor. All MIVIP programs are installed into 386 processor but METCAP programs are installed into Pentium II processors.

1.3 FERO-1

FERO-1 is designed as an information system, which collects the data, manages the data and by processing data, prepares codes for the synoptic and marine observations. FERO-1 is especially designed for the observations at Izmir meteorological station. Also matching the standards of WMO it can be used by another station having the same type observations. FERO-1 notices all the advantages and disadvantages of other systems. So after matching all capabilities of the other programs, it introduces other facilities to users. Using windows operating system, having quality control, database and search procedure makes FERO-1 better than the other systems.

During the design time of FERO-1 observers are consulted to get their ideas about how FERO-1 should be. So it is decided that three main subjects are important for FERO-1, they are Friendship, Quality Control and Database. Because the dynamic menus depend on computer time users do not fill the unnecessary blanks. Every time program looks up to the machine time that is set to Greenwich Mean Time (GMT) and shows the right menu to observer. Even observer wants to do another observation, FER0-1 does not let observer do it. Observation forms make user enter all necessary values will be needed for the observations. So, user never can close the observation unless entering all necessary values.

The third (Actual Pressure) group never added into the synoptic code. So user never has to delete this group for every synoptic code. The fifth group including the pressure tendency and amount of pressure difference is automatically calculated and added to code. For that reason observers are prevented to calculate wrong tendency type and wrong pressure difference. User never looses time for fifth group. When observer begins to fill the blanks at the menus, Quality Control Program warns users after every mistake to correct it. The menus also including some combo boxes make users have no chance to enter wrong values. Database of the program makes user don't loose the values entered to computer. Also searching for any value is easier looking up to the record notebook. FERO-1 gives opportunity to see past month's values instead of looking up different notebooks.

Main menu of FERO-1 lets user choose the application what he or she wants to do. If the application is about searching or editing database, FERO-1 searches the database depending on the request of the user and lets user reach the database to edit it. Observer reaches the past values easily by using searching procedure as well as using the database. Database gives permission to user to edit any meteorological parameter keeping in database. If the application is interested in some computations, FERO-1 computes the request after checking the correctness of the related values. Then for example, observer can get the result of Medium Sea Level pressure, water vapor pressure, humidity and dew point degree procedures. If the application is about filling the observation form, user sees an observation form depending on the real time (GMT (Greenwich Mean Time)). The user fills the blanks and because of this automatic prepared forms, user never fills unnecessary blanks. The entered values are checked by the criteria that are defined by WMO. This time FERO-1 always gets the past observation values from database to compare the entered values whether there are unsuitable values or not. If the values are correct, these values are set into the database as a last observation values, otherwise user have to correct the wrong values that will be placed on the screen as a message by FERO-1. And then user tries to send them to database. This loop continues till finishing all error messages.

The values are coded with the syntax rules of WMO according to the type of the observation. This is done automatically and user never can make FERO-1 code wrong observation type. Program checks the time and the observation type if there is wrong observation type there occurs an error message. If user wants to prepare marine and synoptic observations together, user just click the buttons and FERO-1 prepares them from the database. There is no need for user to give the same values to computer for different observations.

FERO-1 makes observers to do their works faster, gives them opportunities to use the database for their studies, helps them to answer some questions of people calling meteorological station to have information about temperature, humidity and etc.

There are seven observation times for marine and marine explanation observations in a day. Coding these two kinds of observations takes almost an hour of an observer in a day. But there is no time loosing at FERO-1 because, coding these observations uses the same values with the synoptic observation coding. Also observers do not loose time for coding the maximum and minimum temperature observations. By checking the database, program forces the observer to enter the correct value if observer enters higher value than the maximum temperature or lower value than the minimum temperature before the observation.

CHAPTER TWO

AIM OF FERO-1 AND GENERAL STRUCTURE

2.1. AIM OF FERO-1

FERO-1 is the name of the software that is designed for meteorological observations. Main purpose of FERO-1 is to code the marine and synoptic meteorological observations correctly. The other purposes of FERO-1 are to keep the synoptic meteorological information in a database, to control the values entered into the database, to let users to search the database, to calculate the Dew Point Temperature, Humidity, Water Vapour Pressure, Actual Pressure and Mean Sea Level values independently from the observation procedures, to find the daily extremes, to code the synoptic, marine, marine explanation, maximum and minimum observation from the values into the database.

For the design part of the FERO-1 general software design procedure is followed. The principles of software design, functional oriented design and user interface design methods are applied on to FERO-1. To provide consistency, FERO-1 system design is explained in Chapter 2, Chapter 3 and Chapter 4 in detail. So some subjects are referenced from Chapter 3 and Chapter 4 into the Chapter 2. In this Chapter, the general architecture and data flow diagrams of FERO-1 are mentioned.

2.2. SOFTWARE DESIGN

A software design is a model of a real world system that has many participating entities and relationships. The main design activities in the software process are architectural design, system specification, interface design, component design, data structure design and algorithm design. The key point to make a good design is to study and to understand the problem and specify the aim of the problem. It is not possible to identify the solution before understanding the problem. The next step after the understanding the problem and the domain area is to describe the abstraction of the solution with using some graphical, formal or other descriptive notations to describe the components of the design.

A general model of a software design is a directed graph. The target of the design process is the creation of such a graph without inconsistencies. Nodes in this graph represent entities in the design such as processes, functions or types. Links represent relations between design entities such as calls, uses and so on. The stages of the design process can be thought as sequential where as they can be thought as parallel. These stages are architectural design, abstract specification, interface design, component design, data structure design and algorithm design.

This process is repeated for each sub-system until the components identified can be mapped directly into programming language components such as packages, procedures or functions. In the Figure 2.1, a general model of the design process can be seen.

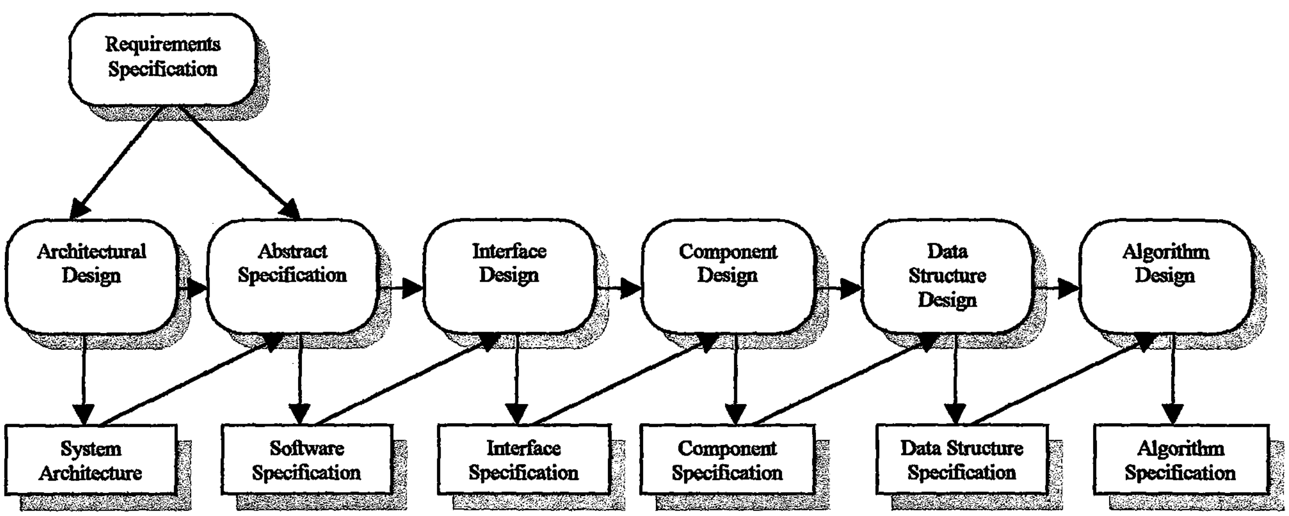

Figure 2.1. A General Model of the Design Process

The most commonly used software design strategy involved decomposing the design into functional components with system state information held in a shared data area. The alternative design strategy is object-oriented design. At functional design the system is designed from a functional viewpoint starting with a high level view and progressively refining this into a more detailed design. At object-oriented design the system viewed as a collection of objects rather than as functions.

There is no general agreement on the notion of a "good design". Design quality metrics may be used to assess if a design is a "good design". The cohesion of a component is a measure of the closeness of the relationships between its components. A component should implement a single logical function or should implement a single logical entity. Coupling is related the cohesion. It is an indication of the strength of interconnections between the components in a design. Designers should aim to produce strongly cohesive and weakly coupled designs. The understandability of a design is important because anyone changing the design must first understand it. There are a number of component characteristics that affect understandability including; cohesion and coupling, naming components, documentation and the complexity. The adaptability of a design is a general estimate of how easy it is to change the design. The providing the adaptability the design should be well documented.

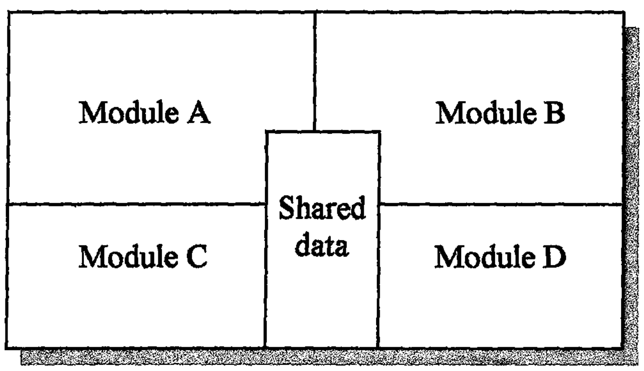

Figure 2.2. Tight Coupling Components for Shared Data Area

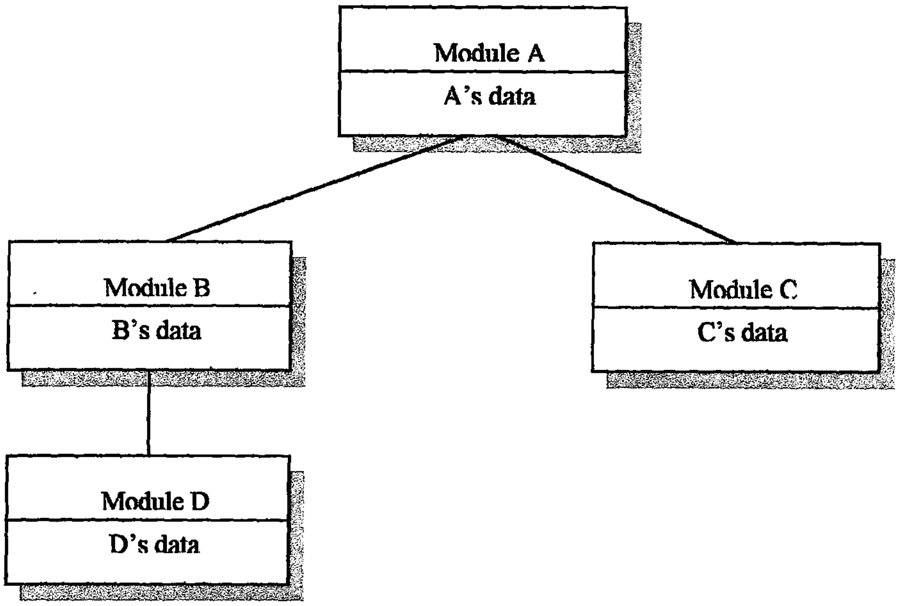

Figure 2.3. Loosely Coupled Components

2.2.1. FUNCTIONAL DESIGN

A software design may be represented as a set of functions, which share system state information. A function-oriented design strategy relies on decomposing the system into a set of interacting functions with a centralized system state shared by these functions. This can be easily shown in Figure 2.4.

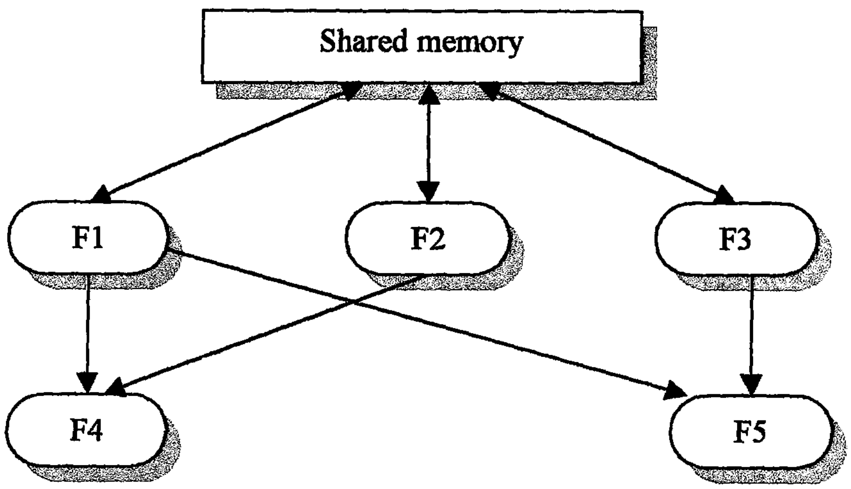

Figure 2.4: A Function-Oriented View of Design.

These functions may also maintain local state information but only for the duration of their execution. The details of an algorithm in a function are hidden but system state information is not hidden in function-oriented design. This can cause problems because a function can change the state in away, which other functions don't expect. If the amount of system state information is minimized and information sharing is explicit then we can say function-oriented design is likely to be successful.

There are three activities of design process called data-flow design, structure decomposition and detailed design description.

Data-flow design is concerned with designing a sequence of functional transformations that convert system inputs into the required outputs. The design is represented as data-flow diagrams. By using data-flow diagrams we can show how data passes through the system and is transformed by each system function. These diagrams are normally understandable without special training, especially if control information excluded. Data-flow diagrams show functional transformations but don't suggest how these might be implemented. A system described in this way might be implemented as a single program using functions or procedures to implement each transformation or alternatively, it could be implemented as a number of communicating tasks.

The structural decomposition model shows how a function is realized by a number of other functions, which it calls. We use structure charts, which are a graphical way to represent this composition hierarchy. They show how one function calls others but don't show the static block structure of a function or a procedure. A designer convert a data-flow diagram to a structure chart but it is not a mechanical process. It requires designer insight and creativity.

Now, the designer should know the organization of the design and what each function should do. Design entity description is concerned whit producing a short design specification of each function. This describes the function, its inputs and its outputs. Making this information explicit usually reveals flaws in the initial decomposition or functions, which have been omitted. The data-flow diagrams and structure charts must be revisited and modified to incorporate the improved understanding of system. The best way to manage these functional descriptions is to maintain them in a data dictionary. Maintaining names and descriptions in a data dictionary reduces the chances of mistakenly reusing names and provides design readers with insights into the designer's thinking. Now it is time to produce detailed designs for each part of the design. These detailed designs should include control information and more precise information about the data structures manipulated.

2.2.2. USER INTERFACE DESIGN

User interface design must take into account, the needs, experience and the capabilities of the system user. Potential users should be involved in the design process. It is impossible to judge user interfaces from an abstract description. Designers must take into account the physical and mental limitations of the humans who use computer systems. Users should not be forced to adapt to an interface because it is convenient to implement. The interface should use terms familiar to the user and the objects manipulated by the system should have direct analogues in the users environment.

Principle	Description
User familiarity	The interface should use terms and concepts which are drawn from the experience of the anticipated class of user.
Consistency	The interface should be consistent in that comparable operations should be activated in the same way.
Minimal surprise	Users should never be surprised by the behaviour of a system.
Recoverability	The interface should include mechanisms to allow users to recover from their errors.
User guidance	The interface should incorporate some form of context - sensitive user guidance and assistance.

Table 2.1: User Interface Design Principles

The designer of a user interface to a computer is faced with two key issues. How can information from the user be provided to the computer system and how can information from the computer system be presented to the user?

Table 2.2 show the principal characteristics of the graphical user interfaces.

Characteristic	Description
Windows	Multiple windows allow different information to be displayed simultaneously on the user's screen.
Icons	Icons different types of information. On some systems, icons represent files; on others, icons represent processes.
Menus	Commands are selected from a menu rather than typed in a command language.
Pointing	A pointing device such as a mouse is used for selecting choices from a menu or indicating items of interest in a window.
Graphics	Graphical elements can be mixed with text on the same display.

Table 2.2: Graphical User Interface Characteristics

In the user interface, error message design is critically important. Poor error messages can mean that a user rejects rather than accepts a system. The background and experience of users should be the determining factor in message design. In the Table 2.3 design factors of specifying the error messages can be seen.

Context	The user guidance system should be aware of what the user is doing and should adjust the output message to the current context.
Experience	As users become familiar with a system they become irritated by long, 'meaningful' messages. However, beginners find it difficult to understand short terse statements of the problem. The user guidance system should provide both types of message and allow the user to control message conciseness.
Skill level	Messages should be tailored to the user's skills as well as their experience. Messages for the different classes of user may be expressed in different ways depending on the terminology which is familiar to the reader.
Style	Messages should be positive rather than negative. They should use the active rather than the passive mode of address. They should never be insulting or try to be funny.
Culture	Wherever possible, the designer of messages should be familiar with the culture of the country where the system is sold. There are distinct cultural differences between Europe, Asia and America. A suitable message for one culture might be unacceptable in another.

Table 2.3: Design Factors of Error Messages in the User Interface

2.3. GENERAL STRUCTURE OF FERO-1

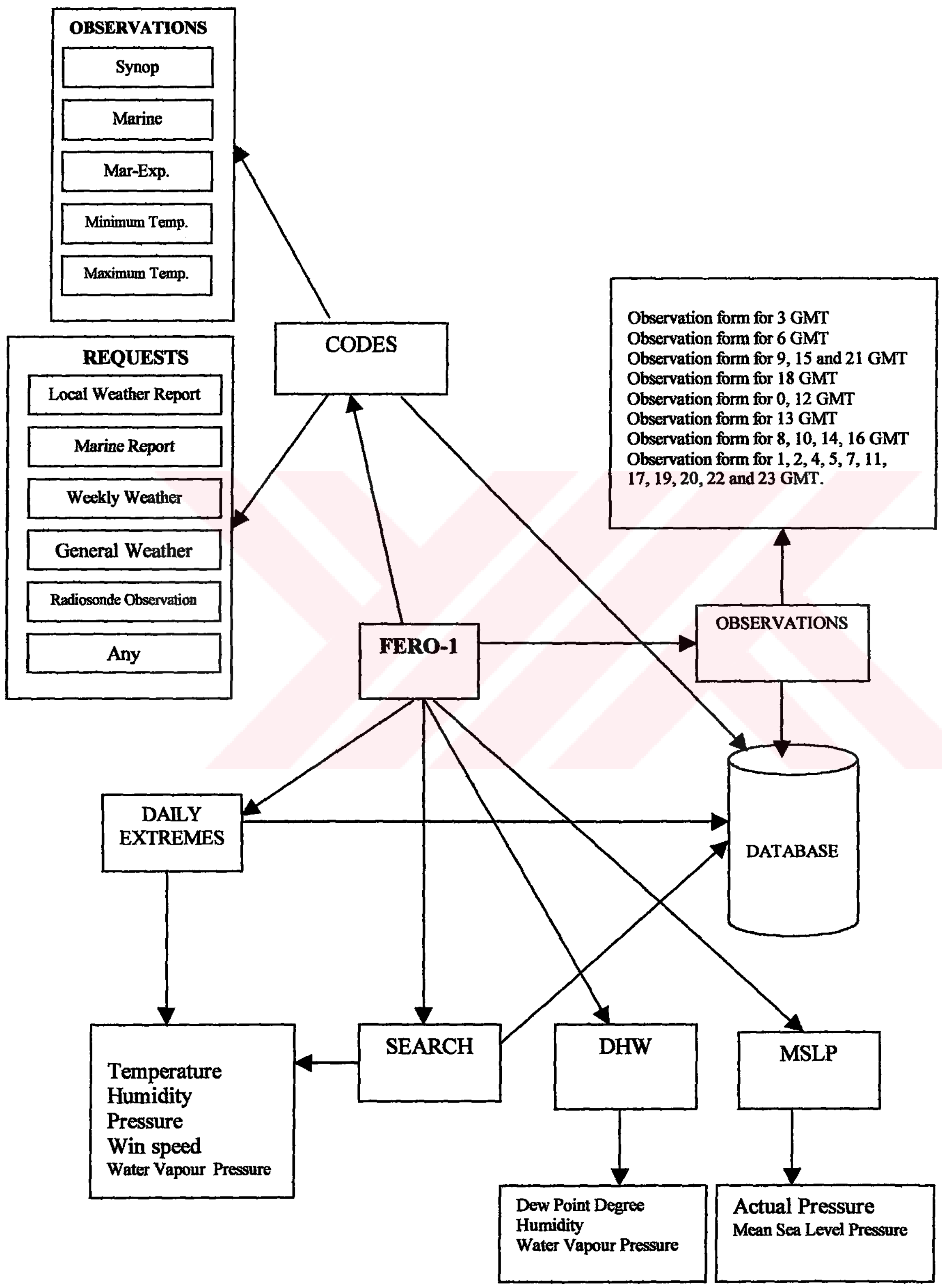

Figure 2.5 Architectural design of FERO-1

FERO-1 is composed from seven different sub systems and all the sub systems of the architectural design of FERO-1 are explained in detailed diagrams in Chapter 3.

FERO-1 is designed according to the functional and user interface design methods. For the functional design part of the FERO-1 the shared memory is set into the main unit of the FERO-1 project. This shared memory is used by the other functions of the different units. All the functions and the steps of these functions are mentioned in Chapter 3. The data dictionary is mentioned in database part of Chapter 3. The general data flow diagram of the input data about the observations and output data about the observation codes can be shown in the Figure 2.6

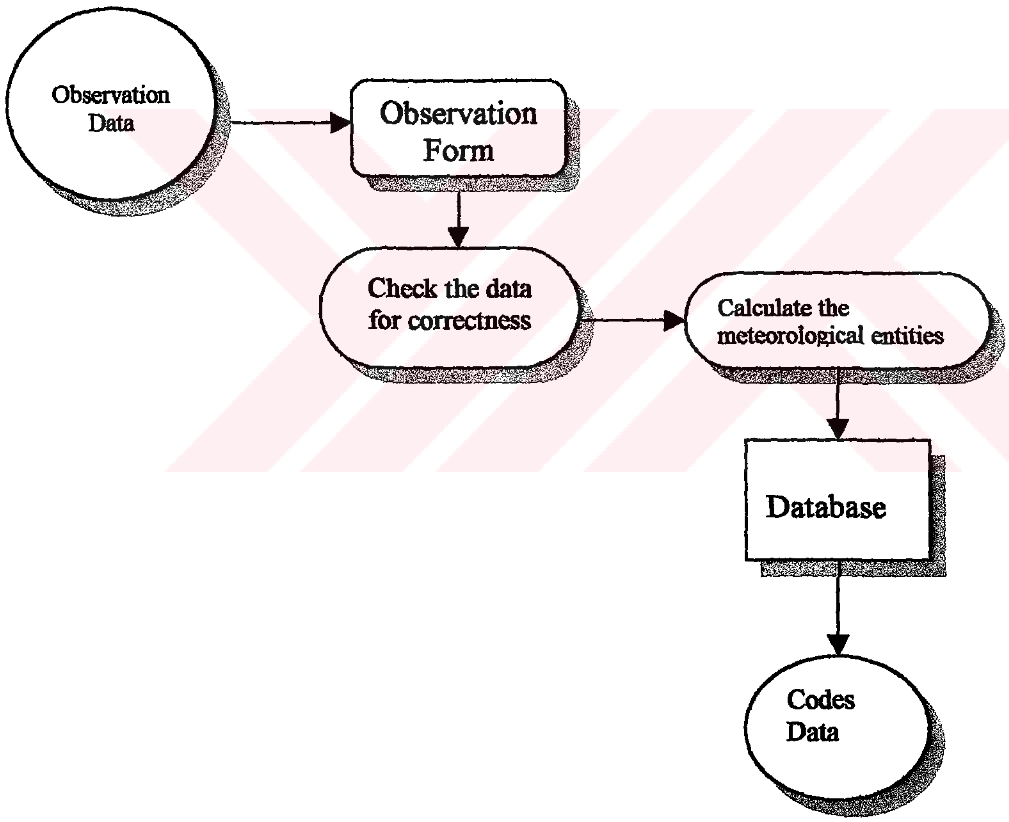

Figure 2.6 General Data Flow Diagram Observation data and Code data

All meteorological entities and the data follow procedures are mentioned at the observation menu part of the chapter 3. The database part of the thesis is the data dictionary part of the project. So, every data in the data dictionary is defined at the database part of the chapter 3. The variables name as chosen from the real indicators of meteorological parameters that are defined by the World Meteorological Organization. For that reason, the variables and the indicators of these variables are written in the codes menu part of the Chapter 3.

The user interface design methods are applied in parallel with the user requirements. The windows, menus, buttons and icons are designed according to the observer's desires and wishes. The names of the windows, menus, buttons and icons are chosen from meteorological terminology. The detailed description of the user interface and the descriptions of the windows, menus, buttons and icons can be found at the User Manual Chapter of the thesis.

The database design and the all definitions about the database are set at the database part of the Chapter 3.

CHAPTER THREE

FERO-1 SYSTEM

3.1 GENERAL INFORMATION ABOUT FERO-1 SYSTEM

FERO-1 is a kind of observation coding system, which is improved for the meteorological synoptic and marine observations that are prepared on land meteorological stations at determined times to match the standards of WMO. FERO-1 is designed to give alternative opportunities about fast and correct coding to the observers working at the meteorological stations in Turkey.

FERO-1 is designed as an information system, which collects the data, manages the data and by processing data, prepares codes for the synoptic and marine observations. FERO-1 is especially designed for Turkish meteorological stations.

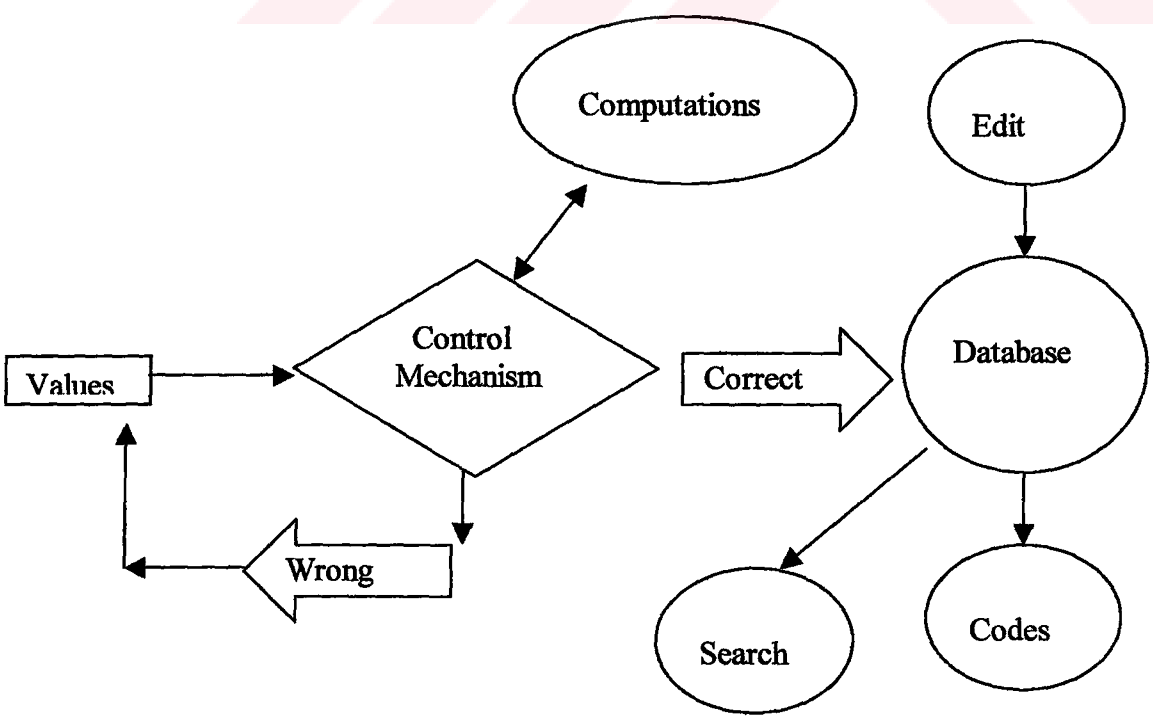

Figure 3.1 General diagram of FERO-1

The Figure 3.1 gives general information about FERO-1. The main features of FERO-1 are as follow:

1. Main menu of FERO-1 lets user to choose the application what he or she wants to do.
2. If the application is about searching or editing database, FERO-1 searches the database depending on the request of the user and lets user reach the database to edit it. Observer reaches the past values easily by using searching procedure as well as using the database.
3. Database gives permission to user to edit any meteorological parameter in database.
4. If the application is interested in some computations, FERO-1 computes the request after checking the correctness of the related values. Then for example, observer can get the result of Medium Sea Level pressure, water vapor pressure, humidity and dew point degree procedures.
5. If the application is about filling the observation form, user sees an observation form depending on the real time (GMT (Greenwich Mean Time)). The user fills the blanks and because of this automatic prepared forms, user never fills unnecessary blanks.
6. The entered values are checked by the criteria that are defined by WMO. This time FERO-1 always gets the past observation values from database to compare the entered values whether there are unsuitable values or not. If the values are correct, these values are set into the database as a last observation values, otherwise user have to correct the wrong values that will be placed on the screen as a message by FERO-1. And then user tries to send them to database. This loop continues till finishing all error messages.
7. The values are coded with the syntax rules of WMO according to the type of the observation. This is done automatically and user never can make FERO-1 to code wrong observation type. Program checks the time

and the observation type if there is wrong observation type there occurs an error message.

3.2 MENUS OF FERO-1

FERO-1 has a simple hierarchical structure and it is shown in Figure 3.2. The searching algorithm and DHW (Dew Point Temperature, Humidity, Water Vapour Pressure) procedure are set on the main menu. So, there are no sub menus for these two parts. About menu, Station Information menu, Database menu, MSL-Pressure menu, Daily extremes menu, Observations menu and Codes menu of FERO-1 is set on the sub menus. The close or the cancel buttons supplies turning back to main menu from the sub menus.

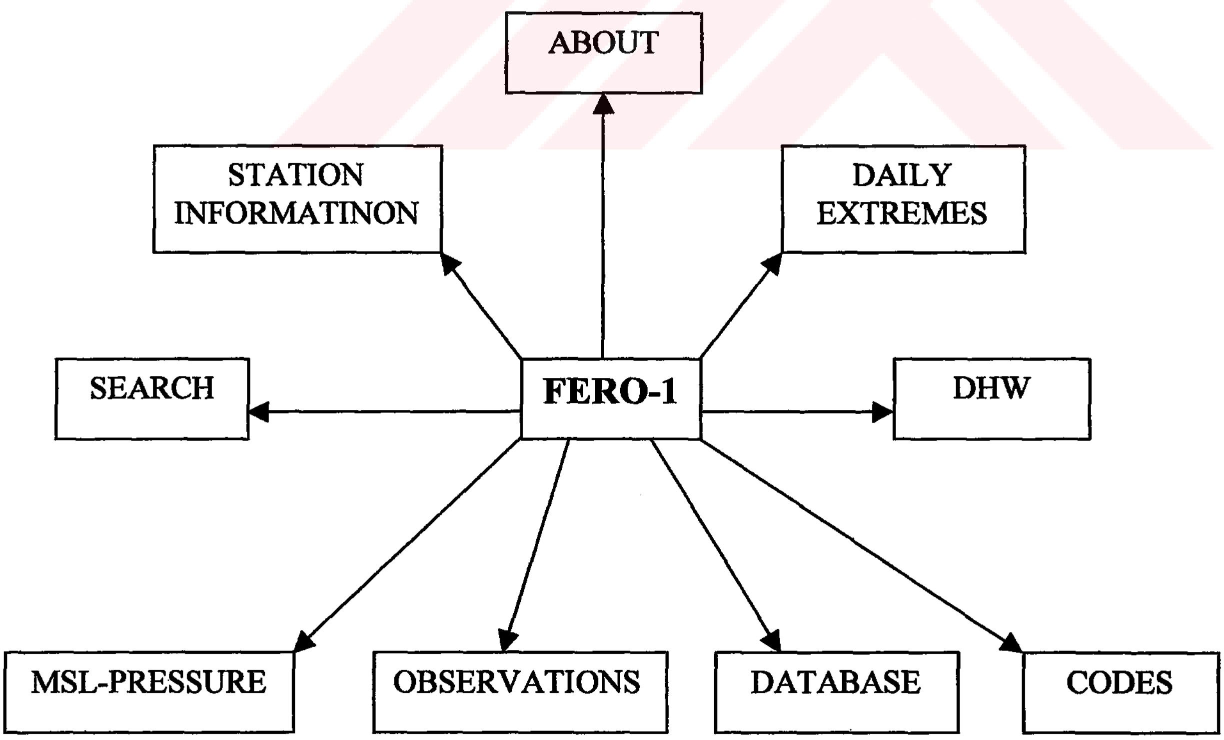

Figure 3.2 The first-degree relation of the FERO-1 hierarchy

3.2.1 ABOUT MENU

This is a window, which gives a small description about the implementer and produce date of FERO-1. Clicking OK button closes this window makes observer turn back to main window.

3.2.2 SEARCH MENU

This procedure helps observer to find the old records from the database. The parameters that are searched are temperature, humidity, wind speed and direction, actual pressure and cloud amount. Observer can get these values from the database by using this procedure instead of the visiting the database menu of FERO-1.

Observer must fill the blanks of parameter, year, month, day and hour exactly. If any blank is empty after clicking search button, FERO-1 warns the user to fill the empty blank by choosing a parameter, year, month, day or hour from the related combo box. If observer fills the blanks, as the database of FERO-1 does not include it then FERO-1 gives a message, as the requested record is not found.

The procedure of search part of FERO-1 is realised as follows.

1. If search button is pressed, then control the combo box menus.
2. If any combo box menu is empty then Show message 'Please choose a .... from the combo box menu'.
3. If all combo boxes are filled, then set the obs table of database to the year, month, day and hour. These fields are the primary key of the table at the same time.
4. If the record is not found, then Show Message 'The record you are looking for is not found'.
5. If the record is found, then set the table to the searched parameter, get the value and show it to the observer.

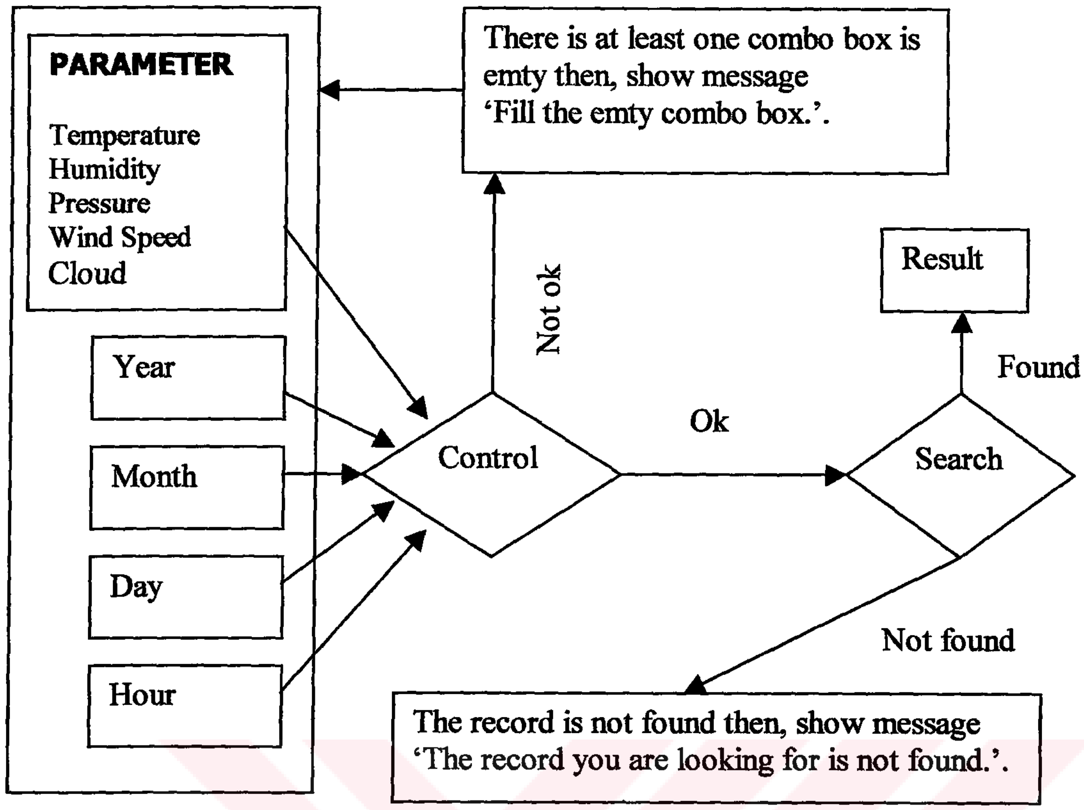

Figure 3.3 Search procedure of FERO-1

3.2.3 DHW MENU

This is a procedure, which calculates the dew point temperature, humidity and water vapor pressure according to the given dry temperature, wet temperature and actual pressure. The detailed explanations and formulations of all these parameters will be mentioned at the database part of the thesis.

Temperature that refers to dry temperature is the degree of hotness or coldness of the ambient air as measured by any suitable instrument. Temperature is determined to the nearest tenth of a degree Celsius at all stations. Temperature values are real values between –50 and 50. There is one digit after the decimal point.

Wet-bulb temperature is a measure of hotness or coldness of the thermometer that has a bulb, which is wet. Wet-bulb temperature is determined to the nearest tenth of a degree Celsius at all stations. Wet-bulb temperature values are real values between –50 and 50. There is one digit after the decimal point.

Atmospheric pressure is the force exerted by the atmosphere at a given point. At Turkish meteorological stations, the term "barograph pressure" refers to the actual pressure. Actual pressure values are real values between 800 and 1050. There is one digit after the decimal point.

Air will normally contain a certain amount of water vapour. The maximum amount of water vapour, that air can contain, depends on the temperature and, for certain temperature ranges, also on whether the air is near to a water or ice surface. The water vapour pressure is changed according to the status of the bulb of the thermometer.

FERO-1 calculates the value of the water vapour pressure using temperature, wet-bulb temperature and actual pressure at the meteorological station. Water vapour pressure takes real values higher than 0. There is one digit after the decimal point.

Dew point temperature or dew point degree is the temperature to which a given parcel of air must be cooled at constant pressure and constant water vapour content in order for saturation to occur.

FERO-1 calculates the dew point temperature by using air temperature, wet-bulb temperature and actual pressure at the station. The value of the dew point temperature is in degree Celsius to tenths. Dew point temperature is determined to the nearest tenth of a degree Celsius.

Relative humidity is the ratio of the actual amount of moisture in the atmosphere to the amount of moisture the atmosphere can hold. Therefore, a relative humidity of 100% means the air can hold no more water (rain or dew is likely), and a relative humidity of 0% indicates there is no moisture in the atmosphere. Meteorologists to help predict the weather use relative humidity.

Relative humidity can be determined from wet bulb and dry bulb temperatures. Dry bulb temperature is the actual air temperature, while wet bulb temperature can be determined by using a filter to cover the bulb of a thermometer.

FERO-1 calculates the humidity by using air temperature, wet-bulb temperature and actual pressure at the station. Humidity field takes real values between 0 and 100. There is one digit after the decimal point.

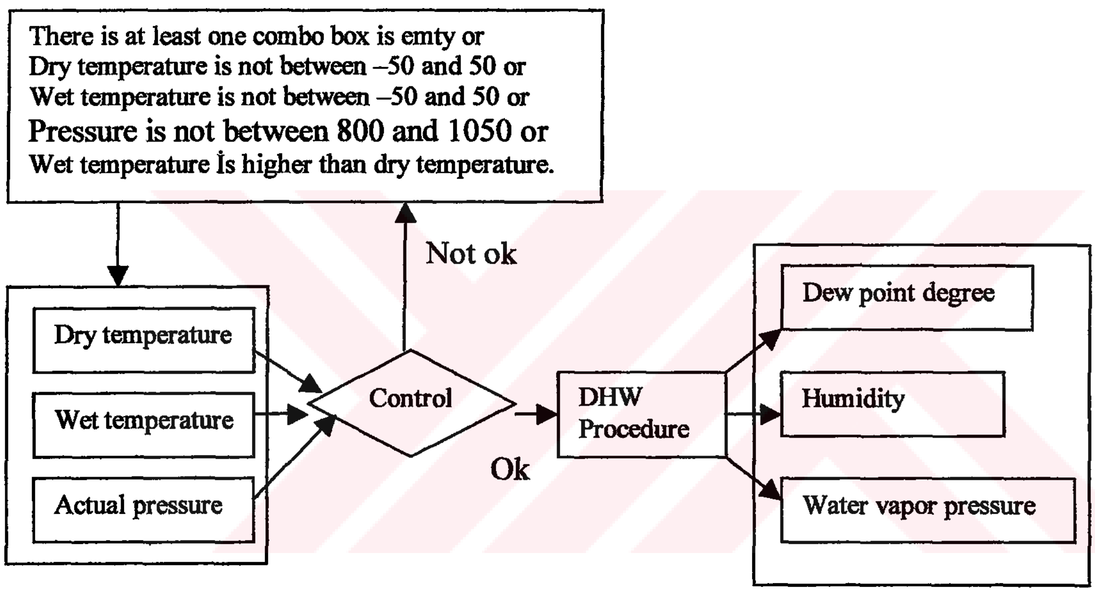

Figure 3.4 DHW procedure of FERO-1

The procedure of DHW part of FERO-1 is realised as follows.

1. If DHW button is pressed, then control the edit menus.
2. If any edit menu is empty then Show message 'Please fill the edit menu for the .... parameter'.
3. If all edit menus are filled, then control the parameters.
4. If dry temperature is not between –50 and 50 then Show Message "Please enter a dry temperature value between -50 C and +50 C '.

5. If wet temperature is not between –50 and 50 then Show Message "Please enter a wet temperature value between -50 C and +50 C '.
6. If pressure is not between 800 and 1050 then Show Message "Please enter a pressure value between 800 mb and 1050 mb '.
7. If wet temperature is higher than dry temperature then Show Message('Wet Temperature can not be higher than Dry Temperature.').
8. If all the values entered correctly then control the wet temperature.
9. If wet temperature is equal or higher than zero then use the first formulation to calculate the water vapour pressure.
10. If wet temperature is less than zero then use the second formulation to calculate the water vapour pressure.
11. Calculate the dew point temperature by using the formulation depending on the water vapor pressure.
12. Calculate the humidity by using the formulation depending on the water vapor pressure.
13. Show the dew point temperature, humidity and water vapor pressure to the observer.

3.2.4 MSL-PRESSURE MENU

This is a procedure that calculates the mean sea level pressure (MSLP) and actual pressure according to the given dry temperature, temperature 12 hours ago, barometer temperature, humidity and barometer pressure. The detailed explanations and formulations of all these parameters will be mentioned at the database part of the thesis.

Atmospheric pressure is the force exerted by the atmosphere at a given point. At Turkish meteorological stations, the term "barograph pressure" refers to the actual pressure. Station pressure is the atmospheric pressure at the meteorological station elevation.

The various pressure parameters shall be determined from the barometric pressure after appropriate corrections are applied. The method used shall depend on the type of sensor and the available computational aids. These aids may be systems that result in a direct readout of the desired parameter, pressure reduction calculators, or tables. FERO-1 gets the actual pressure directly from the barograph as well as uses a formula that calculates the actual pressure from the barometric pressure. Actual pressure takes real values between 800 and 1050. There is one digit after the decimal point.

Mean sea level pressure is a pressure value obtained by the theoretical reduction of barometric pressure to sea level. Where the Earth's surface is above sea level, it is assumed that the atmosphere extends to sea level below the station and that the properties of that hypothetical atmosphere are related to conditions observed at the station.

At meteorological stations, sea-level pressure is computed by adjusting the station pressure to compensate for the difference between the station elevations and sea level. This adjustment is based on the station elevation and the 12-hour mean temperature at the station. The 12-hour mean temperature shall be the average of the present ambient temperature and the ambient temperature 12 hours ago.

FERO-1 calculates the mean sea level pressure form the actual pressure. Also the needed values present temperature and the temperature 12 hours ago. Mean sea level pressure values are real values between 800 and 1050. There is one digit after the decimal point.

FERO-1 uses the following procedure to calibrate the barograph pressure. Also, pressure measurers that clients bring to meteorological station are calibrated by using this procedure.

MSL-Pressure has a simple procedure.

1. Get the values in the edit menus.
2. Use them in the formulations.
3. Calculate the actual pressure and mean sea level pressure.
4. Show them to the observer.
5. Turn back to main menu by using the close button.

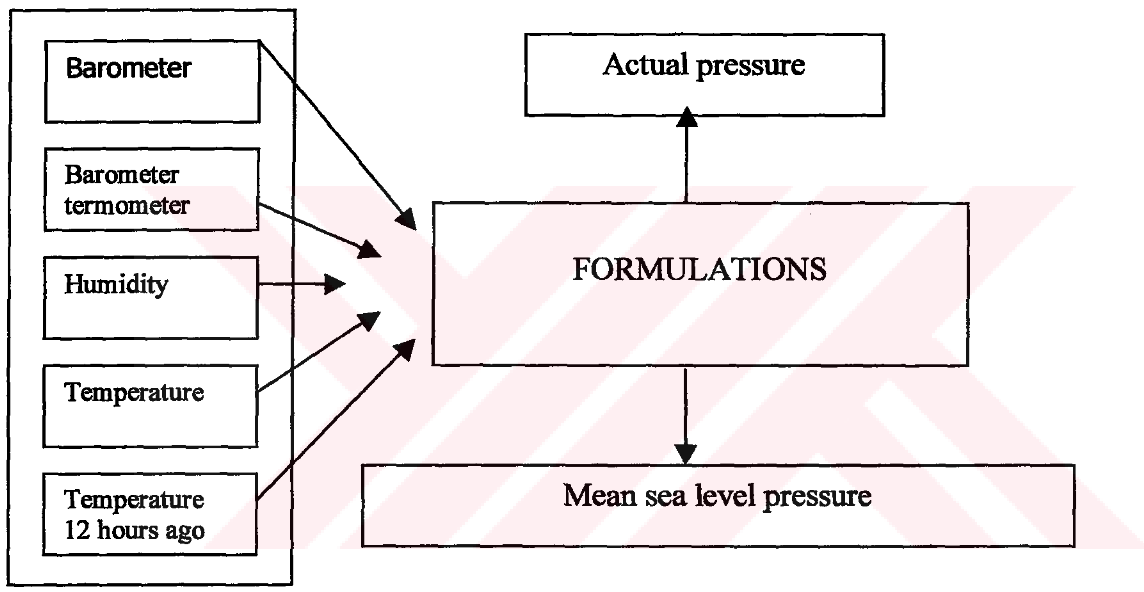

Figure 3.5 Actual pressure and MSLP procedures of FERO-1

3.2.5 STATION INFORMATION MENU

This menu includes the specific information for the meteorological stations. Blanks of country number, station number, station indicator, station name, latitude, wind indicator, radiation type, evaporation type, height from sea level and forecast center have to be filled according to the station properties.

FERO-1 uses some of this information at the calculations and uses others at codes.

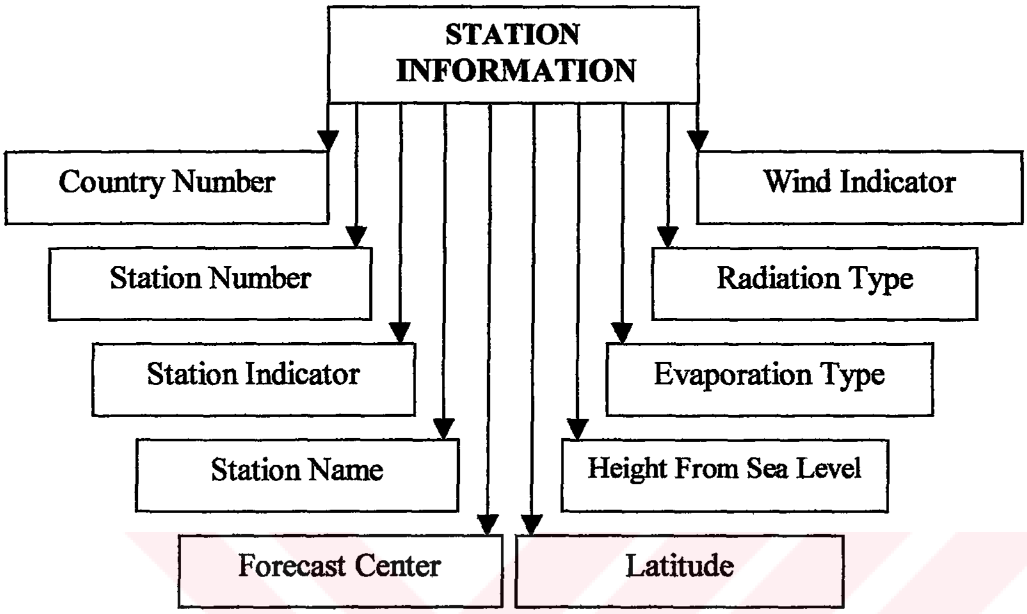

Figure 3.6 Parameters of station information

Country number: Every country that is the member of WMO has a country number. This country number is used at the beginning of the codes to define the country of the meteorological station. For example, 17 is number of Turkey, 16 is number of Italy and 03 is the number of England.

Station number: Every station must have a station number to determine that the code or report is belonged to that station. Station number is unique for every station. It comes after the country number. For example, 220 is station number of Guzelyali and 060 is station number of Yesilkoy. The country number and station number are both used as 17220 or 17060 etc.

FERO-1 uses station number at the beginning of the synoptic observation code and marine observation code.

Station Indicator: Station indicator is same like the station number. It is used to determine the station. Station indicator is used at metar observation code where as station number is used at synoptic observation code. For example GUZL is the station indicator of Guzelyali.

FERO-1 uses station indicator at the headlines of all types of observation codes. For example, SITT60 GUZL 121000, MUTT60 GUZL 031300.

Station name: This is the real name of observation. FERO-1 uses station name at the beginning of the maximum temperature observation code and minimum temperature observation code. For example, GUZELYALI azami: 24.2=

Latitude: This is the real geographical latitude value of the meteorological station. For example, 38.26 is the latitude of Guzelyali. FERO-1 uses latitude at mean sea level pressure and actual pressure calculations.

Wind Indicator: This means that how the wind is measured. 0 means wind is measured by guessing in m/sec. 1 means wind is measured by anemograph in m/sec.
3 means wind is measured by guessing in knot. 4 means wind is measured by anemograph in knot. At Turkish meteorological stations, wind is measured by anemograph in knots so, FERO-1 considers wind indicator as 4 at every observation code.

Radiation type: This means that how the sun radiation is measured. At Turkish meteorological stations, sun radiation is measured by actinography. FERO-1 codes the sun radiation in joule/cm^2. So, FERO-1 considers radiation type as 2 at every observation coding.

Evaporation type: This means that how the evaporation is measured. At Turkish meteorological stations, evaporation is measured by the pich evaporimeter. FERO-1 codes the evaporation type as 2 at every observation coding.

Height from sea level: This is the real height of a meteorological station from the sea level. Height from sea level is important because, it is used at calculations about pressure.

Height from sea level changes from station to station. It is measured in tenths to meter. There is one digit after the decimal point. For example, the height of Guzelyali station from sea level is 28.6 m.

Forecast center: This is the indicator of forecast centre of the meteorological station. The indicator is same as station indicator.

For example, the forecast center of Guzelyali is Adnan Menderes so, the station indicator of Adnan Menderes is LTBJ. FERO-1 uses forecast center at the request reports. For example, MUTT80 LTBJ 110812.

Every time, if FERO –1 needs any one of these information for calculation or coding, it reaches to the edit menus of the station information form where the information is set. Station information is set for one time, but for any reason if any information change is needed then FERO-1 lets user to change the information. Every time if user presses the close button to turn back to main menu, FERO-1 opens a dialog box asking if the observer is sure to change the information. If observer clicks to yes button, FERO-1 lets observer to turn back to main menu. Else, waits for observer to check the information and click the yes button.

3.2.6 OBSERVATION MENU

This procedure has no main menu but has 8 different sub menus. Unless user changes the computer's time, user never can open the form he or she wants. FERO-1 prepares the observation form automatically depending on the computer's time. The observation forms that FERO-1 prepares are: observation form for 3 GMT, observation form for 6 GMT, observation form for 9, 15 and 21 GMT, observation form for 18 GMT, observation form for 0, 12 GMT, observation form for 13 GMT, observation form for 8, 10, 14 and 16 GMT, observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22 and 23 GMT.

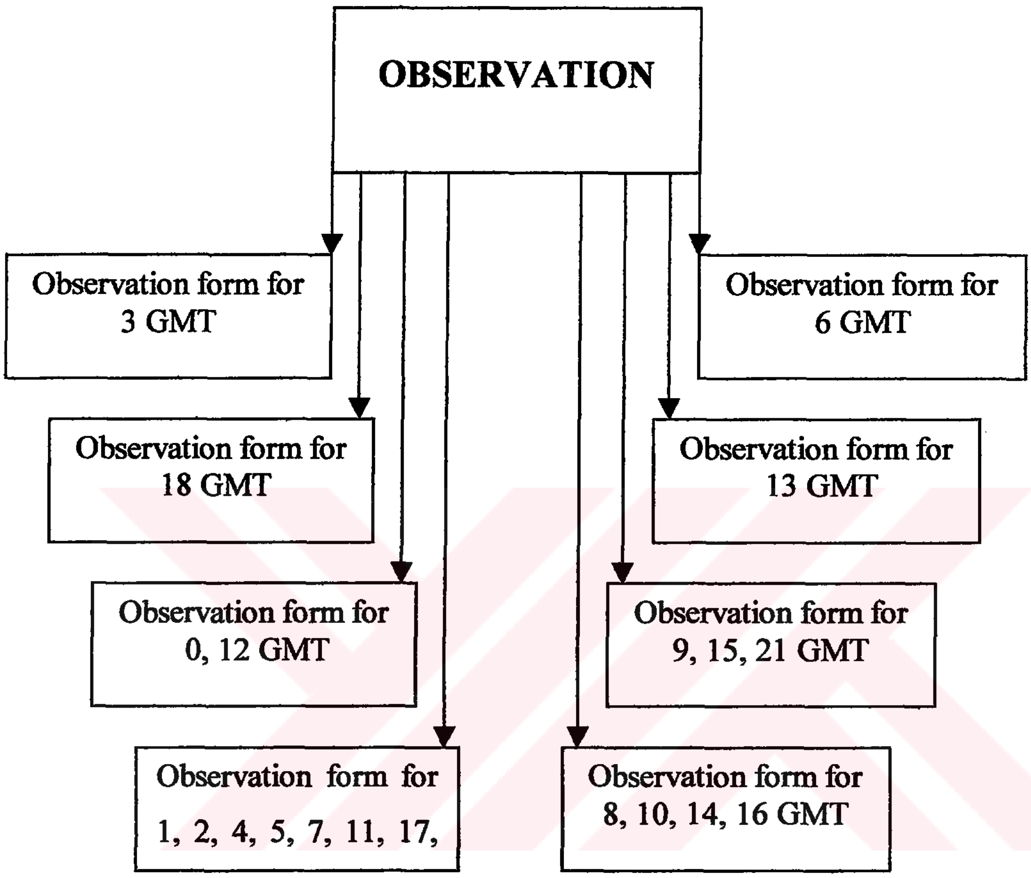

Figure 3.7 Observation forms of FERO-1

These forms are the user interfaces to fill the database fields. Then, after they are sent into the database, FERO-1 uses these values for coding. All of them have at least one different meteorological parameter on it. These forms are prepared because of the different codes. For example, there is no need between the 7 GMT, 13 GMT and 14 GMT synoptic observation code structure but, there is also maximum temperature observation at 13 GMT and there is marine observation at 14 GMT. Not to prepare another form and not to make user to fill the same values, FERO-1 only adds a maximum temperature edit menu on the 13 GMT form and adds a sea status combo box menu on the 14 GMT form.

Also, here is the place where the quality control is made for the database and codes. This quality control is about the meteorological parameters. The relationships between the meteorological parameters are controlled. For example, the lowest cloud amount cannot be higher than the total cloud amount or the humidity must be higher then %70 if the present weather is mist. Also the relationships between the past observations are controlled. For example, the maximum temperature at 13 GMT cannot be less then the temperature between the 6 GMT and 13 GMT observations.

3.2.6.1 OBSERVATION FORMS

There are 24 synoptic observation, 7 marine observation, 1 maximum temperature observation and 1 minimum temperature observation in a day. Some synoptic observations include all marine observation values so; FERO-1 does not prepare any special form for marine observation. Totally 8 observation form is enough to represent all observations. FERO-1 looks up to the computer time and prepares the one hour forwarded observation form to make the code be ready before the new hour. FER0-1 uses the below simple procedure to prepare the observation forms automatically.

1. Decode the time.
2. Hour: = Hour+1.
3. If Hour is 3 then show the observation form for 3 GMT.
4. If Hour is 6 then show the observation form for 6 GMT.
5. If Hour is13 then show the observation form for 13 GMT.
6. If Hour is 18 then show the observation form for 18 GMT.
7. If Hour is 0 or 12 then show the observation form for 0, 12 GMT.
8. If Hour is 9, 15 or 21 then show the observation form for 9, 15, 21 GMT.
9. If Hour is 8, 10, 14 or 16 then show the observation form for 8, 10, 14, 16 GMT.

10. If Hour is 1, 2, 4, 5, 7, 11, 17, 19, 20, 22 or 23 then show the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.

FER0-1 decides which meteorological parameters have to be seen on the observation form according to the below list.

0 GMT: 6 hours synoptic observation.
1 GMT: Hourly synoptic observation.
2 GMT: Hourly synoptic observation.
3 GMT: 3 hours synoptic observation and minimum temperature observation.
4 GMT: Hourly synoptic observation.
5 GMT: Hourly synoptic observation.
6 GMT: 6 hours synoptic observation and marine observation
7 GMT: Hourly synoptic observation.
8 GMT: Hourly synoptic observation and marine observation.
9 GMT: 3 hours synoptic observation.
10 GMT: Hourly synoptic observation and marine observation.
11 GMT: Hourly synoptic observation.
12 GMT: 6 hours synoptic observation and marine observation.
13GMT: Hourly synoptic observation and maximum temperature observation
14 GMT: Hourly synoptic observation and marine observation.
15 GMT: 3 hours synoptic observation.
16 GMT: Hourly synoptic observation and marine observation.
17 GMT: Hourly synoptic observation.
18 GMT: 6 hours synoptic observation and marine observation.
19 GMT: Hourly synoptic observation.
20 GMT: Hourly synoptic observation.
21 GMT: 3 hours synoptic observation.
22 GMT: Hourly synoptic observation.
23 GMT: Hourly synoptic observation.

The difference between the hourly synoptic, 3 hours synoptic and 6 hours synoptic observations are mentioned at following parts about the observation forms.

3.2.6.1.1 OBSERVATION FORM FOR 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT

This form is designed for hourly synoptic observations. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, present weather, past weather1, past weather2, lowest cloud amount, lowest cloud height, low cloud, medium cloud and high cloud parameters on itself.

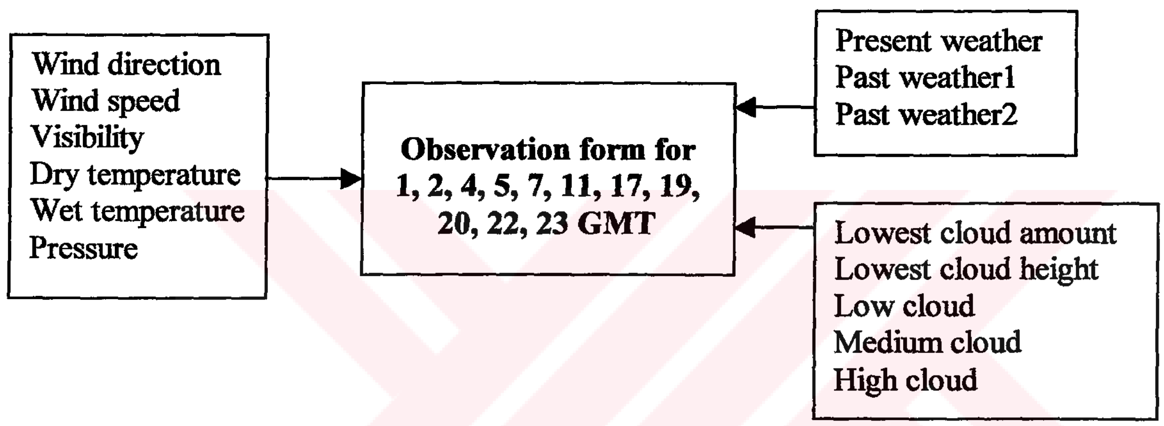

Figure 3.8 Observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT

The meteorological parameters on the left hand side of the figure can be measured every time unless the instruments are broken. These parameters must be determined in the synoptic code so; they have to be filled correctly. If they don't FERO-1 warns the user. The meteorological parameters on the left hand side of the figure cannot be measured every time because, there can be clouds or not, or there can be weather phenomena or not.

There are two ways to turn back to main menu from this form. One way is clicking the cancel button. The other way is clicking the save and close button. After pressing save and close button, FERO-1 begins to apply the quality control to the entered values. If everything is okay then FERO-1 saves the entered values into the database and let user to turn back to the main menu. Else, FERO-1 always gives error messages to observer to correct the values. It continues until everything is okay.

The procedure that FERO-1 follows after pressing save and close button is as follows. All the calculations and meteorological parameters will be mentioned at the database part of FERO-1.

1. Check the edit menus and combo box menus of the meteorological parameters on the right hand side of the figure.
2. If there is any empty edit menu or any combo box menu then show message 'Please fill the empty ..... edit menu or ..... combo box menu'.
3. If every edit menus and every combo box menus are filled then go on.
4. If wind direction is not between 0 and 36 then show message 'Please choose a wind direction from the combo box menu'.
5. If wind speed is not between 0 and 99 then show message 'Please choose a wind speed from the combo box menu'.
6. If visibility is equal 51, 52, 53, 54, 55 then show message ''Please choose a Visibility Value different from 51, 52, 53, 54 and 55'.
7. If dry temperature is not between –50 and 50 then Show Message "Please enter a dry temperature value between -50 C and +50 C '.
8. If the difference of dry temperature and last observation temperature is higher than 5 then show message 'The difference between present temperature and last temperature values must be less than 5 degree. Last temperature is ... degree'.
9. If wet temperature is not between –50 and 50 then Show Message 'Please enter a wet temperature value between -50 C and +50 C '.
10. If the difference of wet temperature and last observation wet temperature is higher than 5 then show message 'The difference between present wet temperature and last wet temperature values must be less than 5 degree. Last wet temperature is ... degree'.

11. If pressure is not between 800 and 1050 then Show Message ''Please enter a pressure value between 800 mb and 1050 mb '.
12. If the difference of pressure and last observation pressure is higher than 10 then show message 'The difference between present pressure and last pressure values must be less than 10 mb. Last pressure is ... degree'.
13. If wet temperature is higher than dry temperature then Show Message 'Wet Temperature can not be higher than Dry Temperature.'.
14. If all the values entered correctly then control the wet temperature.
15. If wet temperature is equal or higher than zero then use the first formulation to calculate the water vapour pressure.
16. If wet temperature is less than zero then use the second formulation to calculate the water vapour pressure.
17. Calculate the dew point temperature by using the formulation depending on the water vapor pressure.
18. Calculate the humidity by using the formulation depending on the water vapor pressure.
19. Show the dew point temperature, humidity and water vapor pressure to the observer at main menu.
20. Check if present weather is empty or not.
21. If present weather is equal 4, 5 or 6 and if humidity is equal or higher than 70 then show message 'Humidity must be less than %70. Humidity is ...... now'
22. If present weather is equal 4 and if visibility is equal or higher than 10 then show message 'Visibility must be less than 10 Km'.
23. If present weather is equal 10 and if humidity is less than 70 then show message 'Humidity must be high than %70. Humidity is ...... now'.
24. If present weather is equal 7, 8 or 9 and if visibility is equal or higher than 8 then show message 'Visibility must be less than 8 Km'.
25. If present weather is equal 5 or 6 and if visibility is equal or higher than 10 then show message 'Visibility must be between 1 Km and 10 Km'.
26. If present weather is equal 11 or 12 and if visibility is equal or less than 1 then show message 'Visibility must be less than 1 Km'.

27. If present weather is equal 10 and if visibility is equal or higher than 10 and if visibility is equal or less then 1 then show message 'Visibility must be between 1 Km and 10 Km'.
28. Check the lowest cloud amount is empty or not.
29. If present weather is equal 17 and if low cloud type is not 9 then show message 'You have to choose 9, for low cloud type'.
30. If lowest cloud amount is higher than total cloud amount then show message 'Lowest Cloud amount can not be higher than Total Cloud amount'.
31. If lowest cloud amount is not empty and if lowest cloud height is empty then show message 'Please fill the lowest cloud height'.
32. If total cloud amount is not empty and if lowest cloud height is empty then show message 'Please fill the lowest cloud height'.
33. Calculate the tendency character.
34. Calculate the tendency amount.
35. Send all the calculated and entered values into the appropriated fields of database.
36. Turn back to main menu.

3.2.6.1.2 OBSERVATION FORM FOR 8, 10, 14, 16 GMT

This form is designed for hourly synoptic observations and for marine observations. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, sea status, present weather, past weather1, past weather2, lowest cloud amount, lowest cloud height, low cloud, medium cloud and high cloud parameters on itself.

The difference of the observation form for 8, 10, 14, 20 GMT is the sea status parameter from the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT. All possibilities of sea status are set into the combo box menu so; observer has to choose one of the items from the combo box menu. So, there is no quality control for this parameter and there will be no error for database field.

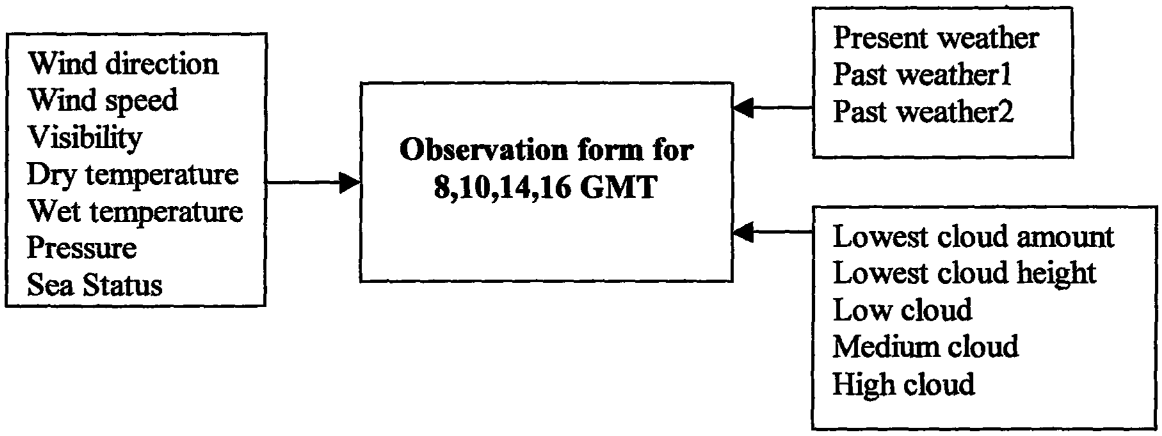

Figure 3.9 Observation form for 8, 10,14,16 GMT

All rules and usage of this form is as same as the past form. The procedure that FERO-1 follows after pressing save and close button is as follows.

1. Apply all quality controls that are applied to the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.
2. Calculate all variables that are calculated at the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.
3. Calculate the sea visibility variable.
4. Send sea status variable and sea visibility variables into the database with the same variables that is sent to database from the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.

3.2.6.1.3 OBSERVATION FORM FOR 13 GMT

This form is designed for hourly synoptic observations and for maximum temperature observation. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, maximum temperature, present weather, past weather1, past weather2, lowest cloud amount, lowest cloud height, low cloud, medium cloud and high cloud parameters on itself.

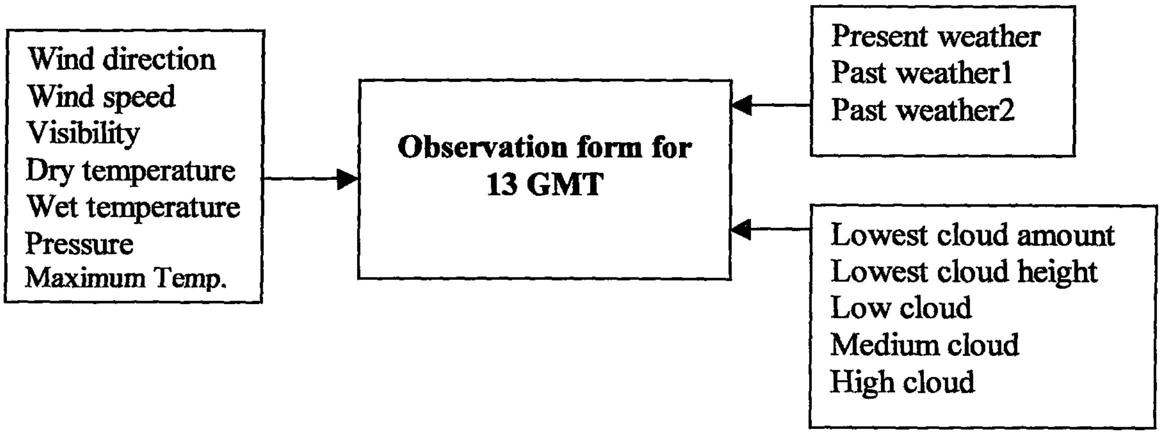

Figure 3.10 Observation form for 13 GMT

The difference of the observation form for 13 GMT is the maximum temperature parameter from the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT. There is an edit menu on the form for maximum temperature.

All rules and usage of this form is as same as the past form. The procedure that FERO-1 follows after pressing save and close button is as follows.

1. Apply all quality controls that are applied to the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.
2. Calculate all variables that are calculated at the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.
5. If maximum temperature is empty then show message 'Please enter a maximum temperature for 13 GMT observation'.
6. Reach the database compare all temperatures from 6 GMT to 13 GMT with the maximum temperature.
7. If any temperature between 6 GMT and 13 GMT is higher than maximum temperature then show message 'The temperature at ... GMT is ... degree and it is higher than your maximum temperature.'

8. Send maximum temperature variable into the database with the same variables that is sent to database from the observation form for 1, 2, 4, 5, 7, 11, 17, 19, 20, 22, 23 GMT.

3.2.6.1.4 OBSERVATION FORM FOR 9, 15, 21 GMT

This form is designed for 3 hours synoptic observations. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, sea status, gust, present weather, past weather1, past weather2, lowest cloud amount, lowest cloud height, low cloud, medium cloud, high cloud, cb cloud amount, cb cloud height, low cloud amount, low cloud type, low cloud height, medium cloud amount, medium cloud type, medium cloud height, high cloud amount, high cloud type, high cloud height parameters on itself.

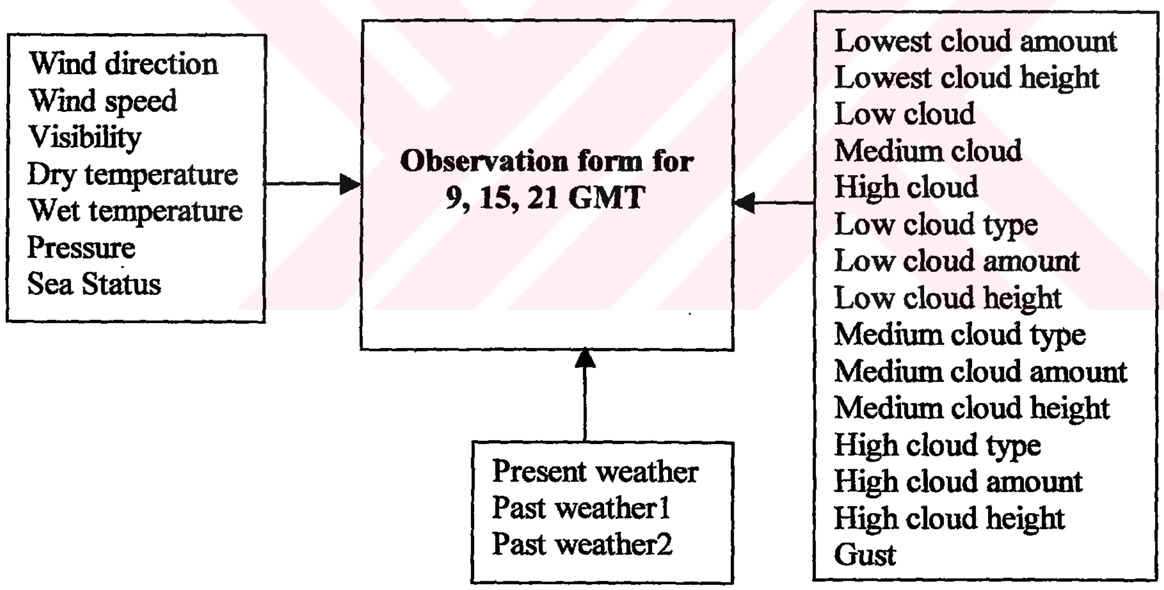

Figure 3.11 Observation form for 9, 15, 21 GMT

The differences of the observation form for 9, 15, 21 GMT is the gust, cb cloud amount, cb cloud height, low cloud amount, low cloud type, low cloud height, medium cloud amount, medium cloud type, medium cloud height, high cloud amount, high cloud type and high cloud height parameters from the observation form for 8, 10,14,16 GMT. There is an edit menu for gust parameter. All possibilities of clouds are set into the combo box menus so; observer has to choose the items from the combo box menus. There is a quality control for gust parameter and quality controls for added clouds.

All rules and usage of this form is as same as the observation form for 8, 10,14,16 GMT. The procedure that FERO-1 follows after pressing save and close button is as follows.

1. Apply all quality controls that are applied to the observation form for 8, 10,14,16 GMT.
2. Calculate all variables that are calculated at the observation form for 8, 10,14,16 GMT.
3. If gust parameter is not empty and if the gust is equal and higher than 20 and if the difference between the gust and wind speed is less than 10 then show message 'The difference between wind speed and gust must be higher than 10 knot'.
4. If low cloud is 9 and if cb cloud amount is empty then show message 'Please fill the cb cloud amount'.
5. If cb cloud amount is not empty and if cb cloud height is empty then show message 'Please fill the cb cloud height'.
6. If low cloud is not empty and if low cloud amount is empty then show message 'Please fill the low cloud amount'.
7. If low cloud amount is not empty and if low cloud type is empty then show message 'Please fill the low cloud type'.
8. If low cloud type is not empty and if low cloud height is empty then show message 'Please fill the low cloud height'.
9. If medium cloud is not empty and if medium cloud amount is empty then show message 'Please fill the medium cloud amount'.
10. If medium cloud amount is not empty and if medium cloud type is empty then show message 'Please fill the medium cloud type'.

11. If medium cloud type is not empty and if medium cloud height is empty then show message 'Please fill the medium cloud height'.
12. If high cloud is not empty and if high cloud amount is empty then show message 'Please fill the high cloud amount'.
13. If high cloud amount is not empty and if high cloud type is empty then show message 'Please fill the high cloud type'.
14. If high cloud type is not empty and if high cloud height is empty then show message 'Please fill the high cloud height'.
15. Send gust variable and cloud variables into the database with the same variables that is sent to database from the observation form for 8, 10, 14, 16 GMT.

3.2.6.1.5 OBSERVATION FORM FOR 3 GMT

This form is designed for 3 hours synoptic observations and for minimum temperature observation. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, sea status, gust, minimum temperature, present weather, past weather1, past weather2, second present weather, lowest cloud amount, lowest cloud height, low cloud, medium cloud, high cloud, cb cloud amount, cb cloud height, low cloud amount, low cloud type, low cloud height, medium cloud amount, medium cloud type, medium cloud height, high cloud amount, high cloud type, high cloud height parameters on itself.

The difference of the observation form for 3 GMT is the minimum temperature parameter from the observation form for 9, 15, 21 GMT. There is an edit menu for minimum temperature parameter.

All rules and usage of this form is as same as the observation form for 9, 15, 21 GMT. The procedure that FERO-1 follows after pressing save and close button is as follows.

1. Apply all quality controls that are applied to the observation form for 9, 15, 21 GMT.
3. Calculate all variables that are calculated at the observation form for 9, 15, 21 GMT.
4. If minimum temperature is empty then show message 'Please enter a minimum temperature for 13 GMT observation'.
5. Reach the database compare all temperatures from 18 GMT to 3 GMT with the minimum temperature.
6. If any temperature between 18 GMT and 3 GMT is less than minimum temperature then show message 'The temperature at ... GMT is ... degree and it is less than your minimum temperature.'
7. If second present weather is higher than present weather then show message 'Your second present weather must be the present weather'.
8. Send minimum temperature variable into the database with the same variables that is sent to database from the observation form for 9, 15, 21 GMT.

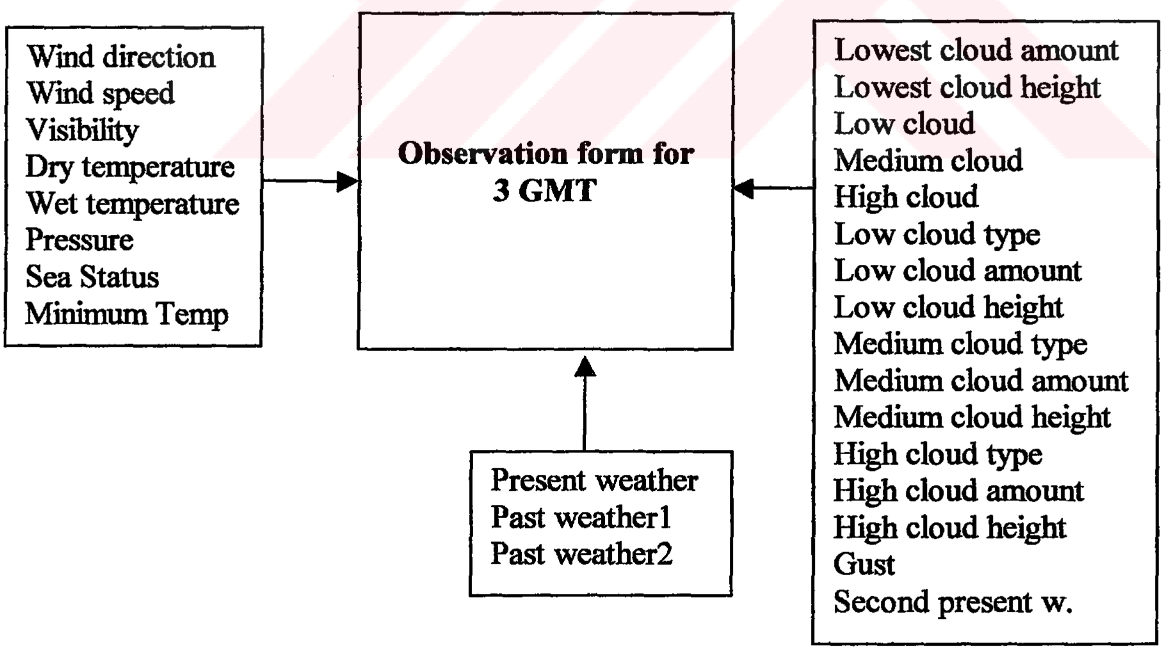

Figure 3.12 Observation form for 3 GMT

3.2.6.1.6 OBSERVATION FORM 0,12 GTM

This form is designed for 6 hours synoptic observations and marine observation. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, sea status, gust, precipitation, fresh snow height, present weather, past weather1, past weather2, lowest cloud amount, lowest cloud height, low cloud, medium cloud, high cloud, cb cloud amount, cb cloud height, low cloud amount, low cloud type, low cloud height, medium cloud amount, medium cloud type, medium cloud height, high cloud amount, high cloud type, high cloud height parameters on itself.

The difference of the observation form for 0, 12 GMT is the precipitation and fresh sow height parameters from the observation form for 9, 15, 21 GMT. There is an edit menu for precipitation parameter and there is an edit menu for fresh snow height parameter. All rules and usage of this form is as same as the observation form for 9, 15, 21 GMT. The procedure that FERO-1 follows after pressing save and close button is as follows.

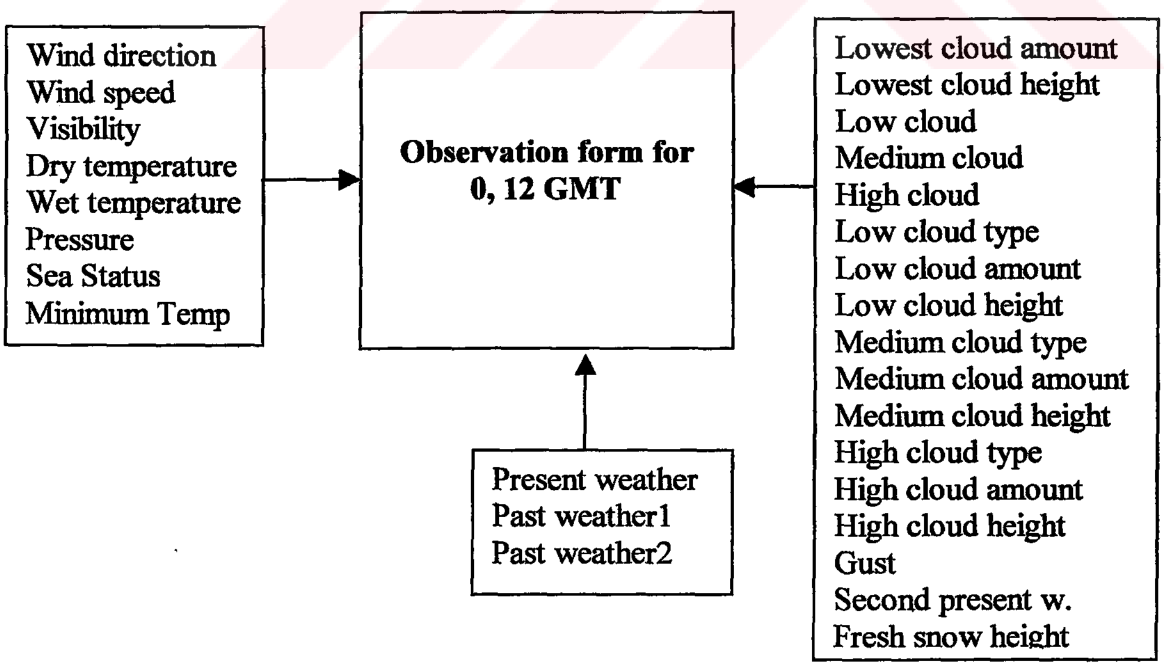

Figure 3.13 Observation form for 0,12 GMT

1. Apply all quality controls that are applied to the observation form for 9, 15, 21 GMT.
2. Calculate all variables that are calculated at the observation form for 9, 15, 21 GMT.
3. Send precipitation variable and fresh snow height into the database with the same variables that is sent to database from the observation form for 9, 15, 21 GMT.

3.2.6.1.7 OBSERVATION FORM FOR 18 GMT

This form is designed for 6 hours synoptic observation and marine observation. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, sea status, gust, precipitation, fresh snow height, maximum temperature, present weather, past weather1, past weather2, lowest cloud amount, lowest cloud height, low cloud, medium cloud, high cloud, cb cloud amount, cb cloud height, low cloud amount, low cloud type, low cloud height, medium cloud amount, medium cloud type, medium cloud height, high cloud amount, high cloud type, high cloud height parameters on itself.

The difference of the observation form for 18 GMT is the maximum temperature parameter from the observation form for 0,12 GMT. There is an edit menu for maximum temperature parameter and there is an quality control for maximum temperature parameter.

All rules and usage of this form is as same as the observation form for 0, 12 GMT. The procedure that FERO-1 follows after pressing save and close button is as follows.

1. Apply all quality controls that are applied to the observation form for 9, 15, 21 GMT.

2. Calculate all variables that are calculated at the observation form for 9, 15, 21 GMT.

3. If maximum temperature is empty then show message 'Please enter a maximum temperature for 18 GMT observation'.

4. Reach the database compare all temperatures from 6 GMT to 18 GMT with the maximum temperature.

5. If any temperature between 6 GMT and 18 GMT is higher than maximum temperature then show message 'The temperature at ... GMT is ... degree and it is higher than your maximum temperature.'

6. Send maximum temperature variable and fresh snow height into the database with the same variables that is sent to database from the observation form for 9, 15, 21 GMT.

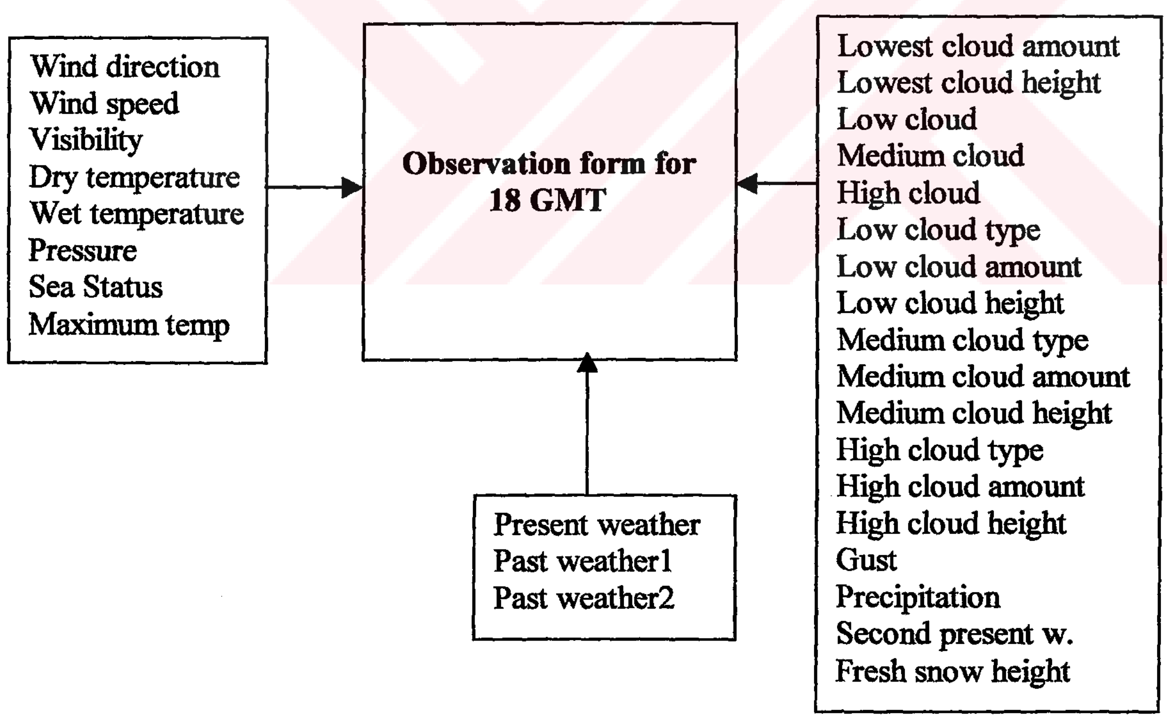

Figure 3.14 Observation form for 18 GMT

3.2.6.1.8 OBSERVATION FORM FOR 6 GMT

This form is designed for 6 hours synoptic observations and marine observation. The form has wind direction, wind speed, visibility, dry temperature, wet temperature, pressure, sea status, gust, precipitation, fresh snow height, minimum temperature, surface, surface temperature, evaporation, radiation, sun shine, present weather, past weather1, past weather2, second present weather, total snow, 24 hours precipitation, height, lowest cloud amount, lowest cloud height, low cloud, medium cloud, high cloud, cb cloud amount, cb cloud height, low cloud amount, low cloud type, low cloud height, medium cloud amount, medium cloud type, medium cloud height, high cloud amount, high cloud type, high cloud height, sea temperature parameters on itself.

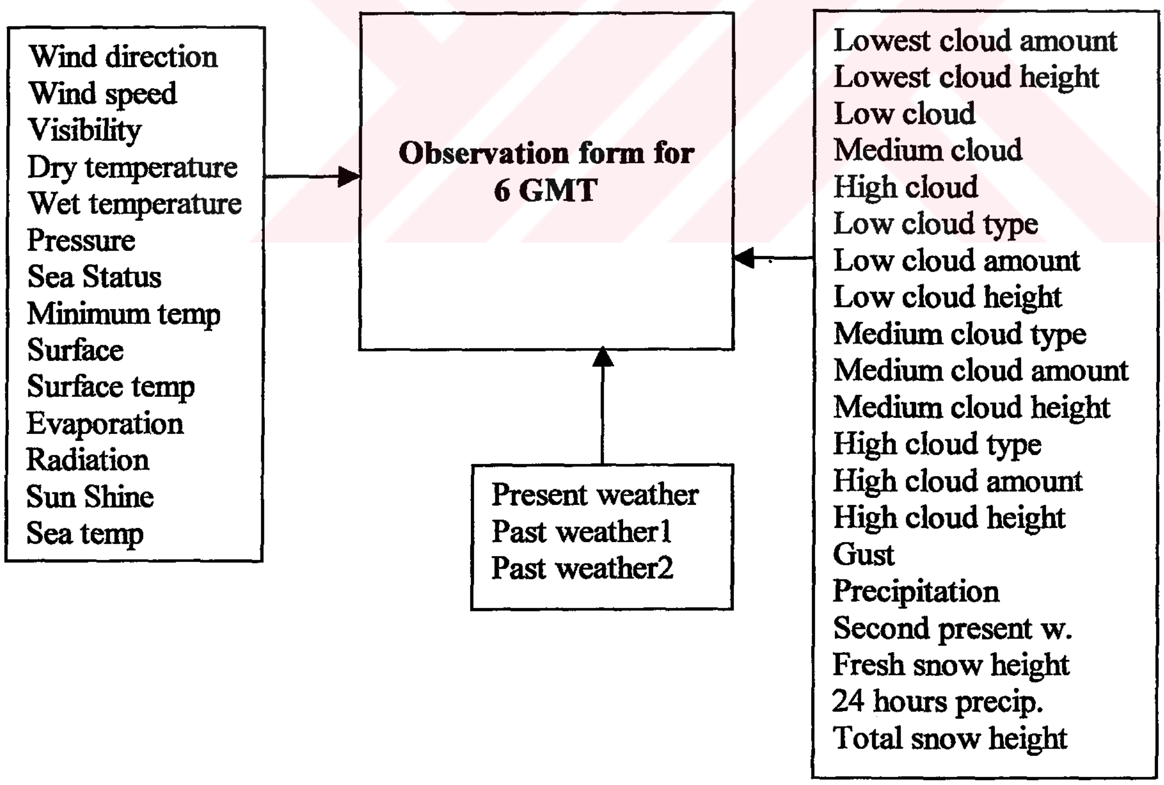

Figure 3.15 Observation form for 6 GMT

The difference of the observation form for 6 GMT is the minimum temperature, surface, surface temperature, evaporation, radiation, sun shine, 24 hours precipitation and total snow height parameters from the observation form for 0,12 GMT. There are edit menus for minimum temperature, surface temperature, evaporation, radiation, sun shine, total snow height, 24 hour precipitation and sea temperature. There is a combo box menu for surface. There is quality control for minimum temperature, evaporation, radiation, and sunshine. Because of the combo box menu including all possibilities for surface there is no quality control for this parameter.

All rules and usage of this form is as same as the observation form for 0, 12 GMT. The procedure that FERO-1 follows after pressing save and close button is as follows.

1. Apply all quality controls that are applied to the observation form for 0, 12 GMT.
2. Calculate all variables that are calculated at the observation form for 0,12 GMT.
3. If minimum temperature is empty then show message ‘Please enter a minimum temperature for 6 GMT observation’.
4. If surface temperature is empty then show message ‘Please enter a surface temperature for 6 GMT observation’.
5. If radiation is empty then show message ‘Please enter a radiation for 6 GMT observation’.
6. If evaporation is empty then show message ‘Please enter a evaporation for 6 GMT observation’.
7. If sunshine is empty then show message ‘Please enter a sunshine for 6 GMT observation’.
8. If precipitation is higher than 24 hours precipitation then show message 'Precipitation cannot be higher than 24 hours precipitation'.
9. If fresh snow height is higher than total snow height then show message 'Fresh snow height cannot be higher than total snow height'.

10. If sea temperature is empty then show message 'Please enter a sea temperature for 6 GMT observation'
11. Reach the database compare all temperatures from 18 GMT to 6 GMT with the minimum temperature.
12. If any temperature between 18 GMT and 6 GMT is less than minimum temperature then show message 'The temperature at ... GMT is ... degree and it is less than your minimum temperature.'
13. Send minimum temperature variable into the database with the same variables that is sent to database from the observation form for 9, 15, 21 GMT.

3.2.7 DATABASE MENU

Database part of FERO-1 is the most important part of the system. The alias name of the database is 'Observation' and it is connected to program by ODBC data source. The Observation Database file is stored into C:\Belgelerim\Observation.mdb. It has just one table called 'Obs'. There is no lock on the database so, every observer can use read or write operations on the database. The size of the database is as big as the free part of the hard disk of the computer used at meteorological station.

Only one table is used because, there is no need to use another table for other observations. 24 synoptic, 7 marine, 7 marine explanation, 1 maximum and 1 minimum observation are coded in a day. By adding different fields into the table, all values of different observations for the same time are reached by the same primary key. All the parameters of meteorological data are stored into the different fields according to their features. The user sends the values into the database by using the interface that is supplied by FERO-1 with the observation forms.

The fields of the database and the features of the fields are:

1. **Year:** This field shows the year of the observation. It takes integer values between 2001 and 2028.

2. **Month:** This field shows the month of the observation. It takes byte values between 1 and 12.

3. **Day:** This field shows the day of the observation. It takes byte values between 1 and 31.

4. **Hour:** This field shows the hour of the observation. It takes byte values between 0 and 23.

These fields called year, month, day and hour are altogether the primary key of the database. These four fields represent any record in the database. These fields get their value from the computer time automatically. Because time of computers is set to Greenwich Mean Time (GMT) at meteorological stations, these fields also represented with GMT.

By international agreement, the reported times for essentially all meteorological reports to include observations and forecast verification times are given according to Universal Coordinated Time (UTC), formerly called Greenwich Mean Time (GMT). GMT times are also referred to as "Z" or, phonetically, "Zulu" times for the letter identifying that time zone cantered on the Greenwich Prime Meridian.

The fields represent the observation time are the most important fields of the database. The database time must be different from the computer time because, observers have to code the observation and send it to centre meteorological service before the coming new hour. For example: If time is 21:45, then observation time has to be as 22. So, observation time has to show one hour later then the computer time. It can be matter at the end of the day and at the end of months. For that reason, at that critic times FERO-1 changes some of the year, month, day and hour fields of FERO-1.

FERO-1 decodes the system time and changes the fields as follow:

Decode the year, month, day and hour.
Hour: = Hour+1.
If Hour: =24 then day: = day+1 and hour: = 0.
If month is January and day =32 then month: =February and day: =day+1.
If month is March and day =32then month: =April and day: =day+1.
If month is April and day =31 then month: =May and day: =day+1.
If month is May and day =32 then month: =June and day: =day+1.
If month is June and day =31 then month: =July and day: =day+1.
If month is July and day =32 then month: =August and day: =day+1.
If month is August and day =32 then month: =September and day: =day+1.
If month is September and day =31 then month: =October and day: =day+1.
If month is October and day =32 then month: =November and day: =day+1.
If month is November and day =31 then month: =October and day: =day+1.
If month is December and day=32 then year:=year+1, month:=December and day:=day+1.
If year is 2004, 2008, 2012, 2016, 2020, 2024 or 2028 and month=February and day=30 then month =March and day: =day+1.
If year is not 2004, 2008, 2012, 2016, 2020, 2024 or 2028 and month=February and day=29 then month =March and day: =day+1.

5. LowestH: This field shows the height of the lowest cloud if there is. It takes byte values between 0 and 10. FERO-1 automatically calculates the number that is written into the LowestH field. It gets the height of the lowest cloud from the observation forms and finds the appropriated number for this height.

FERO-1 finds the LowestH number as follow:

If the sky is not seen then LowestH: =10.
If there is no cloud then LowestH: =9.
If the lowest cloud height is higher than 8200 m. Then LowestH: =9.
If the lowest cloud height is higher is between 6559 and 8201 m. Then LowestH: =8.
If the lowest cloud height is higher is between 4919 and 6560 m. Then LowestH: =7.
If the lowest cloud height is higher is between 3279 and 4920 m. Then LowestH: =6
If the lowest cloud height is higher is between 1967 and 3280 m. Then LowestH: =5.
If the lowest cloud height is higher is between 983 and 1968 m. Then LowestH: =4.
If the lowest cloud height is higher is between 655 and 984 m. Then LowestH: =3.
If the lowest cloud height is higher is between 327 and 656 m. Then LowestH: =2.
If the lowest cloud height is higher is between 163 and 328 m. Then LowestH: =1.
If the lowest cloud height is higher is between 0 and 164 m. Then LowestH: =0.

6. **Visibility:** This field shows the surface visibility. Visibility is a measure of the opacity of the atmosphere. A manually derived visibility value is obtained using the "prevailing visibility" concept. Prevailing visibility is the visibility that is considered representative of visibility conditions at the station; the greatest distance that can be seen throughout at least half the horizon circle, not necessarily continuous. Surface visibility is the prevailing visibility determined from the usual point of observation.

Manually derived visibility shall be evaluated as frequently as practicable. All available visibility reference points shall be used. The greatest distances that can be seen in all directions around the horizon circle shall be determined. When the visibility is greater than the distance to the farthest reference point, the greatest distance seen in each direction shall be estimated. This estimate shall be based on the appearance of the most distant visible reference points. If they are visible with sharp outlines and little blurring of colour, the visibility is much greater than the distance to them. If they can barely be seen and identified, the visibility is about the same as the distance to them. After visibilities have been determined around the entire horizon circle, they shall be resolved into a single value for the observation. To do this, the greatest distance that can be seen throughout at least half the horizon circle is prevailing visibility.

For example: Izmir meteorological station is 6.2 km far away to Hotel Hilton. So, if the observer can see the Hotel Hilton barely, the observation value is 6 km. If the visibility is less than 5 km. visibility value is entered as decimal number and this number has one digit after decimal point. So, visibility field takes positive real values as kilometre. The combo boxes on the observation forms do not include the numbers 51, 52, 53, 54 and 55.It is forbidden to write 51, 52, 53, 54 and 55 km. for visibility to code the visibility group correctly.

7. **Clouds:** This field shows the total cloud cover of the sky over eight. It takes byte values between 0 and 10. FERO-1 fills the field according to the number entered into the observation form.

The value of the Clouds field is written as follows:

If there is no cloud in the sky then Clouds: =0.
If sky is 1/8 covered by clouds then Clouds: =1.
If sky is 2/8 covered by clouds then Clouds: =2.

If sky is 3/8 covered by clouds then Clouds: =3.
If sky is 4/8 covered by clouds then Clouds: =4.
If sky is 5/8 covered by clouds then Clouds: =5.
If sky is 6/8 covered by clouds then Clouds: =6.
If sky is 7/8 covered by clouds then Clouds: =7.
If sky is 8/8 covered by clouds then Clouds: =8.
If sky is unseen then Clouds: =9.
If the measurement is not done then Clouds: =10.

8. WindDir: This field shows the wind direction in 10s of degrees, from which the wind is blowing. Measurement wind direction in fact takes the values between 0 and 360 degree but for easy coding. WindDir field takes byte values between 0 and 36. FERO-1 fills the WindDir field according to the number entered into the observation form. If it sees different value between 0 and 36 it then gives an error message to the observer.

The numbers between 0 and 36 represent the following distances.

If the wind does not blow from any direction or if it is calm then WindDir:=0.
If the wind direction is between 5 and 14 degree then WindDir: =1.
If the wind direction is between 15 and 25 degree then WindDir: =2.
If the wind direction is between 25 and 35 degree then WindDir: =3.
If the wind direction is between 35 and 45 degree then WindDir: =4.
If the wind direction is between 45 and 55 degree then WindDir: =5.
If the wind direction is between 55 and 65 degree then WindDir: =6.
If the wind direction is between 65 and 75 degree then WindDir: =7.
If the wind direction is between 75 and 85 degree then WindDir: =8.
If the wind direction is between 85 and 95 degree then WindDir: =9.
If the wind direction is between 95 and 105 degree then WindDir: =10.
If the wind direction is between 105 and 115 degree then WindDir: =11.
If the wind direction is between 115 and 125 degree then WindDir: =12.
If the wind direction is between 125 and 135 degree then WindDir: =13.

If the wind direction is between 135 and 145 degree then WindDir: =14.

If the wind direction is between 145 and 155 degree then WindDir: =15.

If the wind direction is between 155 and 165 degree then WindDir: =16.

If the wind direction is between 165 and 175 degree then WindDir: =17.

If the wind direction is between 175 and 185 degree then WindDir: =18.

If the wind direction is between 185 and 195 degree then WindDir: =19.

If the wind direction is between 195 and 205 degree then WindDir: =20.

If the wind direction is between 205 and 215 degree then WindDir: =21.

If the wind direction is between 215 and 225 degree then WindDir: =22.

If the wind direction is between 225 and 235 degree then WindDir: =23.

If the wind direction is between 235 and 245 degree then WindDir: =24.

If the wind direction is between 245 and 255 degree then WindDir: =25.

If the wind direction is between 255 and 265 degree then WindDir: =26.

If the wind direction is between 265 and 265 degree then WindDir: =27.

If the wind direction is between 275 and 275 degree then WindDir: =28.

If the wind direction is between 285 and 285 degree then WindDir: =29.

If the wind direction is between 295 and 295 degree then WindDir: =30.

If the wind direction is between 305 and 305 degree then WindDir: =31.

If the wind direction is between 315 and 315 degree then WindDir: =32.

If the wind direction is between 325 and 325 degree then WindDir: =33.

If the wind direction is between 335 and 335 degree then WindDir: =34.

If the wind direction is between 345 and 345 degree then WindDir: =35.

If the wind direction is between 355 and 004 degree then WindDir: =36.

9. WindSpeed: This field shows the speed of the wind. It is the rate, in knots, at which the wind passes a given point. FERO-1 gets the Windspeed value from the observation forms that the observer fills. This field takes byte values between 0 and 256. The number that is read from the observation form is written into the WindSpeed field of the database.

10. Gust: This field shows the description of the variability of the wind speed. FERO-1 gets the Gust value from the observation forms that the observer fills. This field takes byte values between 0 and 256. The number that is read from the observation form is written into the Gust field of the database but there are some constraints.

The wind speed data for the most recent 10 minutes shall be examined to evaluate the occurrence of gusts. Gusts are indicated by rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls. The speed of a gust shall be the maximum instantaneous wind speed.

So, if the wind speed is higher than 9 knots and the difference is more than 10 between the wind speed and the gust, then this gust value is written into the field Gust.

11. Temp: This field shows the real mean temperature for the observation in degree Celsius to tenths. Temperature is a measure of hotness or coldness. On a daily basis, temperature is one of the most widely monitored and disseminated weather parameters obtained from the surface observation. Temperature is the degree of hotness or coldness of the ambient air as measured by any suitable instrument.

The method of obtaining temperature varies according to the system in use at the station. The data may be read directly from digital or analogue readouts, or calculated from other measured values. At most of the Turkish meteorological services, temperatures are measured form the thermometers or from the thermographs by observers. Temperature is determined to the nearest tenth of a degree Celsius at all stations.

Temperature values are between –50 Celsius degree and 50 Celsius degree. So, Temp field takes real values between –50 and 50. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form. The temperature difference of the consecutive records is not higher then 5 Celsius degree.

12. Wtemp: This field shows the real mean wet-bulb temperature for the observation in degree Celsius to tenths. Wet-bulb temperature is a measure of hotness or coldness of the thermometer that has a bulb, which is wet. Wet-bulb temperature is one of the most important weather parameters obtained from the surface observation. Because, wet-bulb temperature is used for calculation of the dew point degree, water vapour pressure and humidity.

The method of obtaining wet bulb temperature is read directly from the thermometer that has a bulb surrounded by a wet filter. Observers wet the filter and use a fan to pass air over the thermometer. As the water evaporates, energy is used and the temperature should decrease. After the temperature has stopped decreasing, record this temperature as the "wet bulb" temperature. Wet-bulb temperature is determined to the nearest tenth of a degree Celsius at all stations.

Wet-bulb temperature values are between –50 Celsius degree and 50 Celsius degree. So Wtemp field takes real values between –50 and 50. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form. The wet-bulb temperature difference of the consecutive records is not higher then 5 Celsius degree.

13. WVPres: This field shows the water vapour pressure of air for the observation in milibar to tenths. Air will normally contain a certain amount of water vapour. The maximum amount of water vapour, that air can contain, depends on the temperature and, for certain temperature ranges, also on whether the air is near to a water or ice surface. If you have a closed container with water and air (like a beaker) then equilibrium will develop, where the air will contain as much vapour as it can. The air will then be saturated with respect to water vapour.

Water vapour pressure is derived from different formulas. One of them which is used by FERO-1 is as follows:

The water vapour pressure is changed according to the status of the bulb of the thermometer. Value of the water pressure depends on temperature, wet-bulb temperature and actual pressure of the station.

If the bulb is wet or if the wet-bulb temperature is higher than 0 then,

Wvp: =A-B where

Wvp is water vapour pressure in milibar,

A:= exp(((7.5*TwTwTw)/(TwTwTw+237.5)+0.7859)*ln(10)),

B:=(TTT-TwTwTw)*0.6666*(PPPP/1007) where

TTT is air temperature in Celsius degree,

TwTwTw is wet-bulb temperature in Celsius degree,

PPPP is actual pressure at the station in milibar.

Else if the bulb is frozen or if the wet-bulb temperature is not higher than 0 then,

Wvp: =A-B where

Wvp is water vapor pressure in milibar,

A: = exp(((9.5*TwTwTw)/(TwTwTw+265.5)+0.7859)*ln(10)),

B:= (TTT-TwTwTw)*0.5733*(PPPP/1007) where

TTT is air temperature in Celsius degree,

TwTwTw is wet-bulb temperature in Celsius degree,

PPPP is actual pressure at the station in milibar.

So WVPres field takes real values higher than 0. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form. This field is not coded for observation but it is used for finding the humidity and the dew point temperature, which is coded.

14. DPTemp: This field shows the temperature to which a given parcel of air must be cooled at constant pressure and constant water vapour content in order for saturation to occur, and it is called dew point temperature or dew point degree. The value of the dew point temperature is in degree Celsius to tenths. Dew point temperature is determined to the nearest tenth of a degree Celsius at all stations.

Now, unfortunately, observers cannot measure the dew point temperature directly. Instead they measure the "wet-bulb" temperature, TwTwTw, which they can infer the ambient vapour pressure with.

FERO-1 calculates the dew point temperature by using air temperature, wet-bulb temperature and actual pressure at the station. Below, there is formula depending on water vapour pressure, which is analysed at the WVPres field.

TdTdTd:=A/B where

TdTdTd is dew point temperature in Celsius degree,

A: =237.3*(ln(Wvp/6.11)/ln(10),

B: =7.5-(ln(Wvp/6.11)/ln(10)) where

Wvp is water vapor pressure in milibar.

So, DPTemp field takes real values between –50 and 50. There is one digit after the decimal point.

15. **Humid** : This field shows the relative humidity of the air. Relative humidity is the ratio of the actual amount of moisture in the atmosphere to the amount of moisture the atmosphere can hold. Therefore, a relative humidity of 100% means the air can hold no more water (rain or dew is likely), and a relative humidity of 0% indicates there is no moisture in the atmosphere. Meteorologists to help predict the weather use relative humidity.

Relative humidity, combined with air temperature, can be used to estimate the actual amount of moisture in the atmosphere, sometimes referred to as perceptible water. Water vapour acts as a green house gas by trapping infrared radiation reflected from the earth. This explains why desert temperatures can become much lower at night, as there is little moisture in the air to trap the heat.

Relative humidity can be determined from wet bulb and dry bulb temperatures. Dry bulb temperature is the actual air temperature, while wet bulb temperature can be determined by using a filter to cover the bulb of a thermometer.

FERO-1 calculates the humidity by using air temperature, wet-bulb temperature and actual pressure at the station. Below, there is formula depending on water vapour pressure, which is analysed at the WVPres field.

Rh:=A/B where

Rh is the relative humidity in the air.

A: =Wvp*100,

B: =exp(((7.5*TTT)/(TTT+237.5)+0.7859)*ln(10)) where

Wvp is water vapour pressure in milibar,

TTT is air temperature in celcius degree.

So, Humid field takes real values between 0 and 100. There is one digit after the decimal point.

16. Pressure: This field shows the actual pressure at the station. Atmospheric pressure is the force exerted by the atmosphere at a given point. At Turkish meteorological stations, the term "barograph pressure" refers to the actual pressure. Station pressure is the atmospheric pressure at the meteorological station elevation.

The various pressure parameters shall be determined from the barometric pressure after appropriate corrections are applied. The method used shall depend on the type of sensor and the available computational aids. These aids may be systems that result in a direct readout of the desired parameter, pressure reduction calculators, or tables. Designated stations may use constants to convert measured pressure to the desired pressure parameter. Station pressure shall be determined by adjusting the corrected barometric pressure to compensate for the difference between the height of the barometer and the designated station elevation.

FERO-1 gets the actual pressure directly from the barograph as well as uses a formula that calculates the actual pressure from the barometric pressure.

The formula to calculate the actual pressure by using barometric pressure is as follows:

APres:=A-B+C where

Apess is actual pressure at the meteorological station in milibar,

A:=PbPbPbPb,

B.=0.000163*PtPtPtPt*PbPbPbPb,

C:=PbPbPbPb*Cos(2*L)/980.665-1 where

PbPbPbPb is barometric pressure in milibar,

PtPtPtPt is temperature of barometer temperature in Celsius degree,

L is latitude degree of the meteorological station.

Actual pressure values are between 800 mb. 1050 mb. So, pressure field takes real values between 800 and 1050. There is one digit after the decimal point. FERO-1 gets the data from the observation form for this field. The actual pressure difference of the consecutive records is not higher then 10mb. The value at this field is not coded for observation. It is used for calculation of the mean sea level pressure and for search algorithm.

17. MSLPres: This field shows the real mean sea level pressure for the day in millibars to tenths. Mean sea level pressure is a pressure value obtained by the theoretical reduction of barometric pressure to sea level. Where the Earth's surface is above sea level, it is assumed that the atmosphere extends to sea level below the station and that the properties of that hypothetical atmosphere are related to conditions observed at the station.

At meteorological stations, sea-level pressure shall be computed by adjusting the station pressure to compensate for the difference between the station elevations and sea level. This adjustment shall be based on the station elevation and the 12-hour mean temperature at the station. The 12-hour mean temperature shall be the average of the present ambient temperature and the ambient temperature 12 hours ago.

FERO-1 calculates the mean sea level pressure form the actual pressure. Also the needed values present temperature and the temperature 12 hours ago are supplied from the database automatically. FERO-1 automatically puts the calculated mean seal level pressure into the MSLP field of the database.

The formulation to calculate the mean sea level pressure is as follows:

MSLP:=Exp((A/(B+C+D+E) *Ln(10))*APres where

MSLP is mean sea level pressure in milibar,

Apres is actual pressure at the station in milibar,

A:= 0.014827*h,

B:= (TTT+t12)/2,

C:= 0.00325*h,

D.= G*(Rh/100),

E:=273.15,

G:=Exp((K/L+M)*Ln(10))*N/Apres,

K:=7.5*TTT,

L:=TTT+237.5,

M:=0.7859,

N: =237.15+TTT,

h is height of station from sea level in meters,

TTT is air temperature in celcius,

Rh is relative humidity of air.

Mean sea level pressure values are between 800 mb. 1050 mb. So, MSLPres field takes real values between 800 and 1050. There is one digit after the decimal point. The mean sea level pressure difference of the consecutive records is not higher then 10mb.

18. Tendency : This field shows the characteristic (an indication of how the pressure has been changing over the past three hours) of the actual pressure. The characteristic shall be based on the observed or recorded (barograms trace) changes in pressure over the past three hours. Designated stations shall include pressure tendency data in each 3 hourly report.

Observer finds the characteristic of pressure tendency from the Table 3.1.

FERO-1 follows the below procedure to find the characteristic:

```
if P3<P then begin
if (P3<P2) and (P<P1) then a:='0'
else if (P2<P3) and ((P2<P1) and ((P3<P1) and (P<P1))) then a:='0'
else if (P3<P2) and (P=P1) then a:='1'
else if (P3=P2) and ((P1>P2) and (P=P1)) then a:='1'
else if (P3>P2) and ((P1<P2) and (P=P1)) then a:='1'
else if (P3<P2) and ((P1>P2) and (P1<P)) then a:='2'
else if (P3<P2) and ((P1=P2) and (P>P1)) then a:='2'
```

```
else if (P2>P3) and ((P2>P1) and ((P3>P1) and (P>P2))) then a:='0'
else if (P3>P2) and (P>P1) then a:='3'
else if (P3=P2) and ((P1>=P2) and (P>P1)) then a:='3'
else if (P2>=P3) and ((P2>P1) and ((P>P1) and (P>P2))) then a:='3'
else a:='1';
end
else if P3=P then begin
if (P3=P2) and ((P1=P2) and (P=P1)) then a:='4'
else  if (P3<P2) and (P<P1) then a:='0'
else  if (P3=P2) and ((P1>P2) and (P<P1)) then a:='0'
else  if (P3>P2) and ((P1>P2) and ((P3<P1) and (P<P1))) then a:='0'
else  if (P3>P2) and (P>P1) then a:='5'
else  if (P3=P2) and ((P1<P2) and (P>P1)) then a:='5'
else  if (P3>P2) and ((P1>P2) and (P=P1)) then a:='5'
else a:='0';
end.
else if P3>P then begin
if (P3>P2) and (P>P1) then a:='5'
else if (P3<P2) and ((P1<P2) and (P>P1)) then a:='5'
else if (P3>P2) and (P=P1) then a:='6'
else if (P3<=P2) and ((P1<P2) and (P=P1)) then a:='6'
else if (P3>P2) and ((P1<=P2) and (P<P1)) then a:='7'
else if (P3>P2) and ((P1>P2) and ((P<P2)and (P<P1))) then a:='7'
else if (P3=P2) and (P<P1) then a:='8'
else if (P3<P2) and ((P1<=P2) and (P<P1)) then a:='8'
else if (P3<P2) and ((P1>P2) and ((P<P2)and (P<P1))) then a:='8'
else if (P3>P2) and ((P1>P2) and ((P3<P1)and (P<P1))) then a:='8'
else a:='6';
end;
end; where
```

a is characteristic of the tendency,

P is actual pressure at meteorological station in milibar,

P1 is actual pressure at meteorological station in milibar one hour ago,
P2 is actual pressure at meteorological station in milibar two hours ago,
P3 is actual pressure at meteorological station in milibar three hours ago.

Because of FERO-1 calculating the characteristic automatically, user never deals with finding characteristic of tendency. There are 9 types of different characteristics so, Tendency field takes byte values between 0 and 8.

Table 3.1 Characteristics of Barometer Tendency

Primary Requirement	Description	Code Figure
Atmospheric pressure now higher than 3 hours ago.	Increasing, then decreasing.	0
	Increasing, then steady, or increasing then increasing more slowly.	1
	Increasing steadily or unsteadily.	2
	Decreasing or steady, then increasing; or increasing then increasing more rapidly.	3
Atmospheric pressure now same as 3 hours ago.	Increasing, then decreasing.	0
	Steady	4
	Decreasing then increasing.	5
Atmospheric pressure now lower than 3 hours ago.	Decreasing, then increasing.	5
	Decreasing, then steady, or decreasing then decreasing more slowly.	6
	Decreasing steadily or unsteadily.	7
	Steady or increasing, then decreasing; or decreasing then decreasing more rapidly.	8

19. Tamount: This field shows the tendency amount of the pressure tendency. Tendency amount is the amount of the pressure change in the past three hours. The amount of pressure change is the absolute value of the change in station pressure or altimeter setting in the past three hours converted to tenths of milibar.

FERO-1 calculates the difference of actual pressure now and actual pressure three hours ago by using the database. The formulation is as follows:

Tamount:=abs(PPPP-P3) where

Tamount is the difference of the actual pressure and the actual pressure 3 hours ago,

PPPP is the actual pressure now,

P3 is the actual pressure 3 hours ago.

TAmount field takes real values. It is seldom seen that the tendency amount is higher than 50 mb. So, generally Tamount field takes the values less than 50. There is one digit after the decimal point.

20. Precip: This field shows the last 6 hours precipitation amount of the observation. The amount of precipitation (water equivalent) accumulated in the past 6 hours, is written into this field. Using a rain gauge does measurement of the 6 hours precipitation. It is determined in millimetre.

The total amount of precipitation, which reaches the ground over a stated period, is expressed as the depth to which it would cover a horizontal surface. The reported accumulation of rainfall is the sum of the amount of liquid precipitation plus the liquid equivalent of any solid precipitation (that is the liquid obtained by melting snow or ice that has fallen).

This field takes integer values between 0 and 999. FERO-1 gets the value from the observation form and directly writes it into the Precip field. The value at Precip field is not coded at every hour. FERO-1 looks up to the time and if it sees that the observation time is 0,6,12,18 GMT then uses this value for the synoptic code.

21. 24Hprep: This field shows the daily total precipitation of the meteorological station. The amount of precipitation (water equivalent) accumulated in the past 24 hours, is written into this field. Using a rain gauge does measurement of the 6 hours precipitation. It is determined in millimetre.

FERO-1 automatically calculates the last 24 hours precipitation. FERO-1 uses the database to sum the 6 hours precipitations. This field takes integer values between 0 and 999. The value at 24Prep field is not coded at every hour. FERO-1 looks up to the time and if it sees that the observation time is 6 GMT then uses this value for the synoptic code.

22. PresentW: This field shows the present weather phenomena at the station. Present weather includes precipitation, obscurations, well-developed dust/sand whirls, squalls, tornadic activity, sandstorms, and duststorms. Present weather may be evaluated instrumentally, manually, or through a combination of instrumental and manual methods. At Turkish meteorological stations this is done manually.

There are 99 types of phenomena for the present weather. The types of present weather can be found from the below list.

Clouds

00 : Clear skies

01 : Clouds dissolving

02 : State of sky unchanged

03 : Clouds developing

Haze, smoke, dust or sand

04 : Visibility reduced by smoke

05 : Haze

06 : Widespread dust in suspension not raised by wind

07 : Dust or sand raised by wind

08 : Well developed dust or sand whirls

09 : Dust or sand storm within sight but not at station

Non-precipitation events

10 : Mist

11 : Patches of shallow fog

12 : Continuous shallow fog

13 : Lightning visible, no thunder heard

14 : Precipitation within sight but not hitting ground

15 : Distant precipitation but not falling at station

16 : Nearby precipitation but not falling at station

17 : Thunderstorm but no precipitation falling at station

18 : Squalls within sight but no precipitation falling at station

19 : Funnel clouds within sight

Precipitation within past hour but not at observation time

20 :Drizzle

21: Rain

22: Snow

23 : Rain and snow

24 : Freezing rain

25 : Rain showers

26 : Snow showers

27 : Hail showers

28 : Fog

29 :Thunderstorms

Duststorm, sandstorm, drifting or blowing snow

30 : Slight to moderate duststorm, decreasing in intensity

31 : Slight to moderate duststorm, no change

32 : Slight to moderate duststorm, increasing in intensity

33 : Severe duststorm, decreasing in intensity

34 : Severe duststorm, no change

35 : Severe duststorm, increasing in intensity

36 : Slight to moderate drifting snow, below eye level

37 : Heavy drifting snow, below eye level

38 : Slight to moderate drifting snow, above eye level

39 : Heavy drifting snow, above eye level

Fog or ice fog

40 : Fog at a distance

41 : Patches of fog

42 : Fog, sky visible, thinning

43 : Fog, sky not visible, thinning

44 : Fog, sky visible, no change

45 : Fog, sky not visible, no change

46 : Fog, sky visible, becoming thicker

47 : Fog, sky not visible, becoming thicker

48 : Fog, depositing rime, sky visible

49 : Fog, depositing rime, sky not visible

Drizzle

50 : Intermittent light drizzle

51 : Continuous light drizzle

52 : Intermittent moderate drizzle

53 : Continuous moderate drizzle
54 : Intermittent heavy drizzle
55 : Continuous heavy drizzle
56 : Light freezing drizzle
57 : Moderate to heavy freezing drizzle
58 : Light drizzle and rain
59 : Moderate to heavy drizzle and rain

Rain

60 : Intermittent light rain
61 : Continuous light rain
62 : Intermittent moderate rain
63 : Continuous moderate rain
64 : Intermittent heavy rain
65 : Continuous heavy rain
66 : Light freezing rain
67 : Moderate to heavy freezing rain
68 : Light rain and snow
69 : Moderate to heavy rain and snow

Snow

70 : Intermittent light snow
71 : Continuous light snow
72 : Intermittent moderate snow
73 : Continuous moderate snow
74 : Intermittent heavy snow
75 : Continuous heavy snow
76 : Diamond dust
77 : Snow grains
78 : Snow crystals
79 : Ice pellets

Showers

80 : Light rain showers

81 : Moderate to heavy rain showers

82 : Violent rain showers

83 : Light rain and snow showers

84 : Moderate to heavy rain and snow showers

85 : Light snow showers

86 : Moderate to heavy snow showers

87 : Light snow/ice pellet showers

88 : Moderate to heavy snow/ice pellet showers

89 : Light hail showers

90 : Moderate to heavy hail showers

Thunderstorms

91 : Thunderstorm in past hour, currently only light rain

92 : Thunderstorm in past hour, currently only moderate to heavy rain

93 : Thunderstorm in past hour, currently only light snow or rain/snow mix

94 : Thunderstorm in past hour, currently only moderate to heavy snow or rain/snow

95 : Tight to moderate thunderstorm

96 : Tight to moderate thunderstorm with hail

97 : Teavy thunderstorm

98 : Teavy thunderstorm with duststorm

99 : Teavy thunderstorm with hail

So, this field takes byte values between 0 and 99. FERO-1 gets the value from the observation form and writes it into the PresentW field of the database.

23. **PastW1:** This field shows the weather phenomena happened in the past not in the last hour. For example it can be raining for present weather but it could be snowing in the past. To define that it was snowing in the past observer uses the past weather.

There are 10 types of phenomena for the present weather. The types of past weather can be found from the bellowing list.

0 : Cloud covering less than half of sky
1 : Cloud covering more than half of sky during part of period and more than half during part of period
2 : Cloud covering more than half of sky
3 : Sandstorm, dust storm or blowing snow
4 : Fog, or thick haze
5 : Drizzle
6 : Rain
7 : Snow or mixed rain and snow
8 : Showers
9 : Thunderstorms

This field takes byte values between 0 and 9. FERO-1 gets the value from the observation form and writes it into the PastW1 field of the database.

24. PastW2: This field shows the weather phenomena happened in the past not in the last hour, too. If there is another second past weather this field is used. Also if there is continuation past weather this field again is used. For example it can be raining for present weather but it could be snowing in the past and it could be raining again before snowing. To define that it was raining before snowing in the past, observer uses the past weather. Also it can be raining in the present as well as it could be raining in the past, at this time, observer uses the past weather with present weather.

There are 9 types of phenomena for the present weather. The types of present weather can be found from the list defined in the PastW1 part. So, this field takes byte values between 0 and 9. FERO-1 gets the value from the observation form and writes it into the PastW2 field of the database.

25. **PresentW2:** This field shows the second present weather phenomena at the station if there is. Second present weather includes precipitation, obscuration, well-developed dust/sand whirls, squalls, tornadic activity, sandstorms, and dust storms. Second present weather may be evaluated instrumentally, manually, or through a combination of instrumental and manual methods. At Turkish meteorological stations this is done manually.

There are 99 types of phenomena for the second present weather and they are same with the weather phenomena for the present weather. The number of the second present weather has to be less than the number of the present weather The types of second present weather can be found from the list defined in the PresentW field.

So, this field takes byte values between 0 and 99. FERO-1 gets the value from the observation form and writes it into the PresentW2 field of the database.

26. **SecCloud:** This field shows the amount of low clouds covering sky, if no low clouds, the amount of the middle clouds. So, this field takes byte values between 0 and 9 as it was mentioned for the Clouds field. FERO-1 gets the value from the observation form and writes it into the SecCloud field of the database.

27. **LT:** This field shows the type of the low clouds covering sky. Observers observe the sky manually and decide the type of the low clouds. There are 9 types of low clouds. The type of the low clouds can be found from the bellowing list.

0 : No low clouds

1 : Cumulus humulis or fractus (no vertical development)
2 : Cumulus mediocris or congestus (moderate vertical development)
3 : Cumulonimbus calvus (no outlines nor anvil)
4 : Stratocumulus cumulogenitus (formed by spreading of cumulus)
5 : Stratocumulus
6 : Stratus nebulosus (continuous sheet)
7 : Stratus or cumulus fractus (bad weather)
8 : Cumulus and stratocumulus (multilevel)
9 : Cumulonimbus with anvil
/ : Low clouds unobserved due to darkness or obscuration

So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form and writes it into the LT field of the database. If FERO-1 sees '/' at the observation form, it considers '/' as number 10.

28. **MT:** This field shows the type of the medium clouds covering sky. Observers observe the sky manually and decide the type of the medium clouds. There are 9 types of medium clouds. The type of medium clouds can be found from bellowing list.

0 : No middle clouds
1 : Altostratus translucidous (mostly transparent)
2 : Altostratus opacus or nimbostratus
3 : Altocumulus translucidous (mostly transparent)
4 : Patches of altocumulus (irregular, lenticular)
5 : Bands of altocumulus
6 : Altocumulus cumulogenitus (formed by spreading of cumulus)
7 : Altocumulus (multilayers)
8 : Altocumulus castellanus (having cumuliform tufts)
9 : Altocumulus of a chaotic sky
/ : Middle clouds unobserved due to darkness or obscuration

So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form and writes it into the MT field of the database. If FERO-1 sees '/' at the observation form, it considers '/' as number 10.

29. **HT:** This field shows the type of the high clouds covering sky. Observers observe the sky manually and decide the type of the high clouds. There are 9 types of high clouds. The type of high clouds can be found from bellowing list.

0 : No high clouds
1 : Cirrus fibratus (wispy)
2 : Cirrus spissatus (dense in patches)
3 : Cirrus spissatus cumulogenitus (formed out of anvil)
4 : Cirrus unicus or fibratus (progressively invading sky)
5 : Bands of cirrus or cirrostratus invading sky (less than 45 degree above horizon)
6 : Bands of cirrus or cirrostratus invading sky (more than 45 degree above horizon)
7 : Cirrostratus covering whole sky
8 : Cirrostratus not covering sky but not invading
9 : Cirrocumulus
/ : High clouds unobserved due to darkness or obscuration

So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form and writes it into the HT field of the database. If FERO-1 sees '/' at the observation form, it considers '/' as number 10.

30. **CCN:** This field shows the cloud coverage of the cumulonimbus cloud. The cumulonimbus cloud is the most important cloud at meteorology science. Because, cumulonimbus cloud is the reason of all dangerous weather phenomena such as thunderstorm and heavy showers. So, there is special group for cumulonimbus cloud in the code.

Cloud coverage of cumulonimbus is found as the definition mentioned at Clouds field. So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form.

31. CCT: This field shows the genus of cumulonimbus cloud. The genus of cumulonimbus cloud is 9. Also the genus of the other clouds can be seen in the following list.

0 : Cirrus (Ci)
1 : Cirrocumulus (Cc)
2 : Cirrostratus (Cs)
3 : Altocumulus (Ac)
4 : Altostratus (As)
5 : Nimbostratus (Ns)
6 : Stratocumulus (Sc)
7 : Stratus (St)
8 : Cumulus (Cu)
9 : Cumulonimbus (Cb)
/ : Cloud not visible

So, this field takes byte value 9. FERO-1 writes the 9 into the field automatically if it sees any information for cumulonimbus in the observation form.

32. CCH: This field shows the height of the cumulonimbus cloud base. The height of the cloud base is represented in meter or feet. At Turkish meteorological station, it is represented in feet. For example, consider the height of the cumulonimbus meter as 3000 feet; this will be coded as 30. If the height of the clouds is over 5000 feet, then the first digit of the heigt is summed with 50. For example, 6000 feet is represented with 56. For easy coding, heigts are represented with two digit numbers in the observation forms. So, fields show the heights of clouds takes two digit numbers.

Height of cumulonimbus cloud base changes in 2300 to 3700 feet. So, this field takes byte values between 23 and 37. FERO-1 gets the value from the observation form.

33. **LCN:** This field shows the cloud coverage of the low cloud. Cloud coverage of low cloud is found as the definition mentioned at Clouds field. So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form.

34. **LCT:** This field shows the genus of low cloud. The low clouds are cumulus, stratocumulus and stratus. So the genus of low cloud is 6, 7 or 8. So, this field takes byte values of 6, 7 or 8. FERO-1 gets the value from the observation form.

35. **LCH:** This field shows the height of the low cloud base. Height of low cloud base changes in 2500 to 4500 feet. So, this field takes byte values between 25 and 45. FERO-1 gets the value from the observation form.

36. **MCN:** This field shows the cloud coverage of the medium cloud. Cloud coverage of medium cloud is found as the definition mentioned at Clouds field. So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form.

37. **MCT:** This field shows the genus of medium cloud. The medium clouds are altocumulus, altostratus and nimbostratus. So the genus of medium cloud is 3, 4 or 5. So, this field takes byte values of 3, 4 or 5. FERO-1 gets the value from the observation form.

38. MCH: This field shows the height of the medium cloud base. Height of medium cloud base changes in 6000 to 16000 feet. So, this field takes byte values between 56 and 66. FERO-1 gets the value from the observation form.

39. HCN: This field shows the cloud coverage of the high cloud. Cloud coverage of high cloud is found as the definition mentioned at Clouds field. So, this field takes byte values between 0 and 10. FERO-1 gets the value from the observation form.

40. HCT: This field shows the genus of high cloud. The high clouds are cirrus, cirrocumulus and cirrostratus. So the genus of high cloud is 0, 1 or 2. So, this field takes byte values of 0, 1 or 2. FERO-1 gets the value from the observation form.

41. HCH: This field shows the height of the high cloud base. Height of high cloud base changes in 17000 to 27000 feet. So, this field takes byte values between 67 and 77. FERO-1 gets the value from the observation form.

42. MaxTemp: This field shows the maximum temperature in degree Celsius to tenths. This field is used two times a day. One time is to define the highest temperature for the previous 12 hours and the other is to define the highest temperature for previous 7 hours.

At Turkish meteorological services, maximum temperature is measured form the thermometer called maximum temperature. Maximum temperature is determined to the nearest tenth of a degree Celsius at all stations.

Maximum temperature values are between –50 Celsius degree and 50 Celsius degree. So, MaxTemp field takes real values between –50 and 50. There is one digit after the decimal point. FERO-1 gets the data from the observation form for this field. At 13 GMT maximum temperature observations, the maximum temperature cannot be less than the previous 7 hours temperatures and at 18 GMT synoptic observations, it cannot be less than the previous 12 hours temperature.

43. MinTemp: This field shows the minimum temperature in degree Celsius to tenths. This field is used two times a day. One time is to define the lowest temperature for the previous 12 hours and the other is to define the lowest temperature for previous 9 hours.

At Turkish meteorological services, minimum temperature is measured form the thermometer called minimum temperature. Minimum temperature is determined to the nearest tenth of a degree Celsius at all stations.

Minimum temperature values are between –50 Celsius degree and 50 Celsius degree. So, MinTemp field takes real values between –50 and 50. There is one digit after the decimal point. FERO-1 gets the data from the observation form for this field. At 3 GMT minimum temperature observation, the minimum temperature cannot be higher than the previous 9 hours, and at 6 GMT synoptic observation, can not be higher than the previous 12 hours temperature

44. Surface: This field shows the state of ground without snow or measurable ice cover. There are different 9 types for the state of ground as in the following list.

0 : Ground is dry
1 : Ground is damp
2 : Ground is wet. (There are small or big water masses on the surface)
3 : Ground is covered with water by the result of the flood
4 : Frost on the ground

5 : Ground is transparent iced.
6 : Ground is covered with dust and sand but not completely.
7 : Thin dry dust or sand cover covering ground completely
8 : Thick dry dust or sand cover covering ground completely
9 : Ground is drought

So, this field takes byte values between 0 and 9. FERO-1 gets the data from the observation form for this field.

45. SurfTemp: This field shows the minimum temperature over the grass. The grass minimum temperature is the lowest temperature reached overnight by a thermometer freely exposed to the sky with its bulb just touching the tips of short grass (25 to 50 mm above the ground). Normally the thermometer is exposed at the last hour before sunset and the reading is taken next morning.

At Turkish meteorological services, grass minimum temperature is measured form the thermometer called grass minimum temperature. Grass minimum temperature is determined to the nearest tenth of a degree Celsius at all stations.

Grass minimum temperature values are between –50 Celsius degree and 50 Celsius degree. So, SurfTemp field takes real values between –50 and 50. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form.

46. SurfIceSnow: This field shows state of ground with snow or measurable ice cover. There are different 9 types for the state of ground as in the following list.

0 : Predominantly covered with ice
1 : Compact or wet snow covering less than half of ground
2 : Compact or wet snow covering more than half of ground but not completely covered

3 : Even layer of compact or wet snow covering entire ground
4 : Uneven layer of compact or wet snow covering entire ground
5 : Loose dry snow covering less than half of ground
6 : Loose dry snow covering more than half of ground but not completely covered
7 : Even layer of loose dry snow covering entire ground
8 : Uneven layer of loose dry snow covering entire ground
9 : Snow covering ground completely with deep drifts

So, this field takes byte values between 0 and 9. FERO-1 gets the data from the observation form for this field.

47. **SnowHeight:** This field shows the total snow depth in cm. It takes integer values between 0 and 999. FERO-1 gets the data for this field from the observation form.

48. **Evapo:** This field shows the evaporation amount for the last 24 hours. It is measured from the pich evaporimeter. It takes real values. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form.

49. **SunShine:** This field shows the sunshine duration for the last 24 hours. There is an instrument to measure the sunshine duration. The instrument has a mounted glass sphere, which focuses the suns rays onto a thick card, burning a hole when the sun is shining. The passage of the sun across the sky translates into a linear burn pattern along the card, which may be analysed by the observer to give measurements of sunshine duration.

So, it takes real values. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form.

50. Radiation: This field shows the amount of the sun radiation for the last 24 hours. It takes real values. There is one digit after the decimal point. FERO-1 gets the data for this field from the observation form.

51. NSHeight: This field shows the fresh snow depth in cm. It takes integer values between 0 and 999. FERO-1 gets the for this field data from the observation form.

52. SeaStatus: This field shows the status of the sea. It takes integer values between 0 and 9. FERO-1 gets the data from the observation form for this field. The meanings of the numbers as follow:

0: Calm (0 m)
1: Slight agitation (0-0.1m)
2: Small waves (0.1-0.5 m)
3: Waves between small and medium (0.5-1.25m)
4: Medium waves (1.25-2.5m)
5: Big waves (2.5-4m)
6: Very big waves (4-6m)
7: High waves (6-9m)
8: Very high waves (9-14m)
9: Terrible waves (Higher than 14m)

53. SeaVis: This field shows the horizontal visibility in km. There are defined numbers for some visibility intervals. FERO-1 automatically finds the sea visibility code from value at the visibility field. FERO-1 applies the bellowing procedure to find the code number.

```
v:=Visibility
if v>=50 then sv:=9
else if (v<50) and (v>=20) then sv:=8
```

```
else if (v<20) and (v>=10) then sv:=7
else if (v<10) and (v>=4) then sv:=6
else if (v<4) and (v>=2) then sv:=5
else if (v<2) and (v>=1) then sv:=4
else if (v<1) and (v>=0.5) then sv:=3
else if (v<0.5) and (v>=0.2) then sv:=2
else if (v<0.2) and (v>=0.05) then sv:=1
else if v<0.05 then sv:=0
Sea visibility:=sv.
```

It takes integer values between 0 and 9. Because of FERO-1 finding the value of SeaVis variable, there is no need to make observer to enter this value into the database.

54. SeaTemp: This field shows the temperature of seawater in degree and tenths. It takes real values. There is one digit after the decimal point. FERO-1 gets the data from the observation form for this field.

3.2.8 CODES MENU

The last process of the FERO-1 is coding the observations. There are different 5 types of observation to be coded. They are synoptic, marine, marine explanation, maximum temperature and minimum temperature observations. The World Meteorological Organisation (WMO) determines syntaxes of all observation codes. All needed values are received from the observation database and from the station information form. Also, some values are calculated at the coding part of FERO-1. There are request codes for observers to get information about weather forecast, marine forecast and observations, from the centre meteorological office or from the forecast centre.

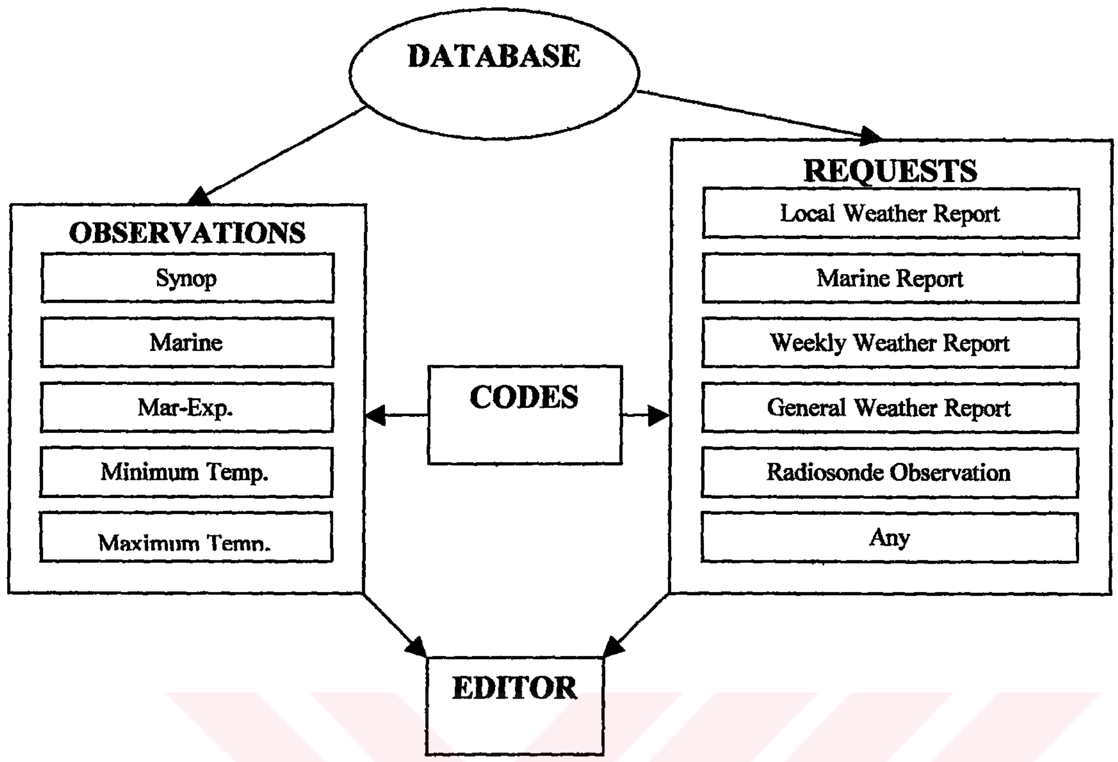

Figure 3.16 Coding part of FERO-1

3.2.8.1 CODING SYNOPTIC OBSERVATIONS

There are also 4 different coding syntaxes for synoptic observations that are determined according to their features about being hourly, 3 hours, 6 hours observations and including special groups.

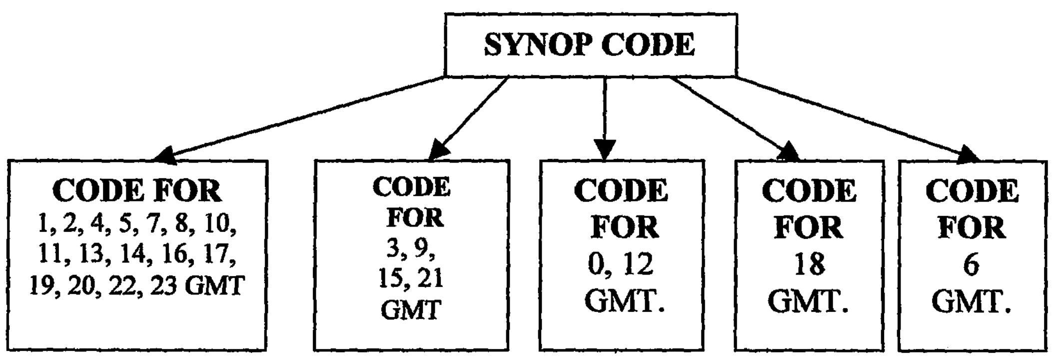

Figure 3.17 Types of synop code.

Surface synoptic observation syntax for 1, 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, 17, 19, 20, 22, 23 GMT:

HSDD SI YYGG00

SSD YYGGIw

IIiii IrIxhVV Nddff 1SnTTT 2SnTdTdTd 4PPPP 5aPPP 7WWW1W2 8NhClCmCh=

Surface synoptic observation syntax for 3, 9, 15, 21 GMT:

HSDD SI YYGG00

SSD YYGGIw

IIiii IrIxhVV Nddff 1SnTTT 2SnTdTdTd 4PPPP 5aPPP 7WWW1W2 8NhClCmCh 333 8NsChchs 910ff 924SVs 960ww =

Surface synoptic observation syntax for 0, 12 GMT :

HSDD SI YYGG00

SSD YYGGIw

IIiii IrIxhVV Nddff 1SnTTT 2SnTdTdTd 4PPPP 5aPPP 6RRRTr 7WWW1W2 8NhClCmCh 333 8NsChchs 910ff 924SVs 931ss 960ww =

Surface synoptic observation syntax for 18 GMT :

HSDD SI YYGG00

SSD YYGGIw

IIiii IrIxhVV Nddff 1SnTTT 2SnTdTdTd 4PPPP 5aPPP 6RRRTr 7WWW1W2 8NhClCmCh 333 1SnTxTxTx 8NsChchs 910ff 924SVs 931ss 960ww =

Surface synoptic observation syntax for 6 GMT :

HSDD SI YYGG00

SSD YYGGIw

IIiii IrIxhVV Nddff 1SnTTT 2SnTdTdTd 4PPPP 5aPPP 6RRRTr 7WWW1W2 8NhClCmCh 333 2SnTmTmTm 3EsnTgTg 4ESSS 5EEEIe 55sss J5F24F24F24 7R24R24R24R24 8NsChchs 910ff 924SVs 931ss 960ww 555 0SnTwTwTw =

3.2.8.2 CODING MARINE OBSERVATIONS

There are also 4 different coding syntaxes for marine observations that are determined according to having sea temperature group and to be written in Turkish language.

Marine synoptic observation syntax for 6 GMT:
HSDD SI YYGG00
SSD YYGGIw
IIiii Nddff 1SnTTT 4PPPP 7WWW1W2 0SnTwTwTw 924SVs =

Marine synoptic observation syntax for 8, 10, 12, 14, 16, 18 GMT:
HSDD SI YYGG00
SSD YYGGIw
IIiii Nddff 1SnTTT 4PPPP 7WWW1W2 924SVs =

Marine explanation syntax for 6 GMT.
HSDD SI YYGG00
SN ‘ :’ N, dd ‘DAN’ ff ‘NAT’, S, Vs,
TTT ‘DERECE’, ‘DENİZ SUYU SICAKLIĞI’ TwTwTw ‘DERECE’ =

Marine explanation syntax for 8, 10, 12, 14, 16, 18 GMT.
HSDD SI YYGG00
SN ‘:’N, dd ‘DAN’ ff ‘NAT’, S, Vs,
TTT ‘DERECE’ =

3.2.8.3 CODING TEMPERATURE OBSERVATIONS

There are two different temperature observation coding syntax.

Maximum temperature observation syntax for 13 GMT:

HSDD SI YYGG00
SN Azami:TTT=

Minimum temperature observation syntax for 3 GMT:

HSDD SI YYGG00
SN Asgari:TTT=

3.2.8.4 DEFINITION OF CODES

The same variables in the different codes have same meanings. Sometimes they can be coded differently according to the time. At marine explanation observations, meteorological parameters are used with Turkish language. For example, at synop code, 13.2 degree for temperature is coded as '10132' but in marine explanation it is coded as '13.2 DERECE'.

HSDD: Observation identifier

For hourly and 3 hours synoptic observations SITT60, for 6 hours synoptic observation SMTT60, for marine observation DGTT60, for marine explanation DATT60, for maximum observation and minimum observation MUTT80 are used. According to the clicking button FERO-1 chooses the HSDD variable. Also FERO-1 uses HSDD for requests. For local weather report MUTT80, for general weather report FPTU01, for marine report FQTU01, for weekly weather report FPTU02, for radiosonde observations USTT66, UKTT66, ULTT66, UETT66, are used.

SI: Station indicator.

FERO-1 gets it from the station information form.

YYGG00: Day and hour of the observation.

YY: Day of the observation.

GG: Hour of the observation.

00: It is constant.

The constraint for YY and GG is that they must have two characters like 12, 03, 05, 22 etc. not like 2, 4, 9 etc. So, FERO-1;

1. Opens the observation database.
2. Reaches to the last record.
3. Gets the values at day and hour fields.
4. Checks them.
5. If YY is less then 10 then considers it as 0YY string like 05, if YY is equal or greater than 10 then considers it as YY, like 11.
6. If GG is less then 10 then considers it as 0GG string like 05, if GG is equal or greater than 10 then considers it as GG, like 11.

SSD: Station type.

For synoptic observation AAXX, for marine observation BBXX are used. FERO-1 finds it according the observation type.

YYGGIw: Day, hour and wind indicator of observation.

Iw: Wind indicator of observation.

Iw takes different values according to the measurement of wind. 0 is used for measurement by guessing in m/sn, 1 is used measurement by anemograph in m/sn, 3 is used for measurement by guessing in knot and 4 is used for measurement by anemograph in knot. At Turkish meteorological stations 4 is used for Iw and FERO-1 gets it from the station information form.

IIiii: Country number and station number of station.

II: Country number.

iii: Station number.

FERO-1 gets these values from the station information form.

IrIxhVV: Data about Precipitation and weather groups, base of lowest cloud and horizontal visibility.

Ir: Inclusion or omission of precipitation data.

FERO-1 looks up to the observation database for the last record, if it sees any number different from 0 at the Precip field then considers Ir as 1; this means that there is precipitation group in the code. Else, it considers Ir as 2; this means there is not precipitation group in the code.

Ix: Inclusion or omission of weather group.

FERO-1 looks up to the observation database for the last record, if it sees any number higher than 4 at the PresentW, PastW1, PastW2 fields then considers Ix as 1; this means that there is weather group in the code. Else, it considers Ix as 2; this means there is not weather group in the code.

h: Height of base of lowest cloud.

FERO-1 gets it from the observation field looking up to the LowestH field. The number over there is calculated by FERO-1 before coding. . If h is equal to 10 then, FERO-1 considers h as'/'.

VV : Horizontal visibility.

The codes to code the visibility values are as follows.

00 : less than 0.1 km

01 : 0.1 km

02 : 0.2 km

...

50 : 5.0 km

56 : 6 km

57 : 7 km

...

80 : 30 km

81 : 35 km

82 : 40 km

83 : 45 km

84 : 50 km

85 : 55 km

86 : 60 km

87 : 65 km

88 : 70 km

89 : greater than 70 km

FERO-1 gets the visibility value from the visibility field of the observation database. Then applies the following procedure to find the code.

VV:=Visibility.
If VV<0.1 then VV:=0,
Else if VV<=5 then VV:=10*VV,
Else if (VV>5) and (VV<=30) then VV:=50+VV
Else if VV=35 then VV:=81
Else if VV=40 then VV:=82
Else if VV=45 then VV:=83
Else if VV=50 then VV:=84
Else if VV=55 then VV:=85
Else if VV=60 then VV:=86
Else if VV=65 then VV:=87
Else if VV=70 then VV:=88
Else if VV>70 then VV:=89;

VV must have two characters so if VV<10 then FERO-1 considers VV as 0VV else considers VV as VV.

Nddff: Total cloud amount, wind speed and direction.

N: Total Cloud amount.

FERO-1 gets it from the observation database looking up to the Clouds field. The number over there was calculated by FERO-1 before coding. If N is equal to 10 then, FERO-1 considers N as'/'.

dd: Wind direction in tens of degrees.

FERO-1 gets it from the observation database looking up to the WindDir field. dd must have two characters so; if dd<10 then FERO-1 considers dd as 0dd else considers dd as dd.

ff: Wind speed in knots.

FERO-1 gets it from the observation database looking up to the WindSpeed field. ff must have two characters so; if ff<10 then FERO-1 considers ff as 0ff else considers ff as ff.

1SnTTT: Temperature.

1: Indicator.

Sn: Sign of temperature (0=positive, 1=negative).

TTT: Dry-bulb temperature in tenths of a degree Celsius.

FERO-1 gets it from the observation database looking up to the Temp field. Then apply the following procedure to code the sign and temperature together. SnTTT must have 4 characters.

TTT:=Temperature.

TTT:=10*TTT.

If (TTT<10) and (TTT>=0) then SnTTT:=000TTT.

Else if (TTT>=10) and (TTT<100) then SnTTT:=00TTT.

Else if (TTT>=100) then SnTTT:=0TTT

Else if (TTT<0) and (TTT>-10) then SnTTT:=100TTT.

Else if (TTT<=-10) and (TTT>-100) then SnTTT:=10TTT.

Else if (TTT<=-100) then SnTTT:=1TTT.

2SnTdTdTd: Dew point temperature.

2: Indicator (0=positive, 1=negative).

Sn: Sign of temperature

TdTdTd: Dew-point temperature in tenths of a degree Celsius

FERO-1 gets it from the observation database looking up to the DPTemp field. Then apply the following procedure to code the sign and dew point temperature together. SnTdTdTd must have 4 characters.

TTT:= Dew point temperature.
TdTdTd:=10*TdTdTd.
If (TdTdTd<10) and (TdTdTd>=0) then SnTdTdTd:=000TdTdTd.
Else if (TdTdTd>=10) and (TdTdTd<100) then SnTdTdTd:=00TdTdTd.
Else if (TdTdTd>=100) then SnTdTdTd:=0TdTdTd
Else if (TdTdTd<0) and (TdTdTd>-10) then SnTdTdTd:=100TdTdTd.
Else if (TdTdTd<=-10) and (TdTdTd>-100) then SnTdTdTd:=10TdTdTd.
Else if (TdTdTd<=-100) then SnTdTdTd:=1TdTdTd.

4PPPP: Mean sea level pressure.

4: Indicator

PPPP: Last four digits of mean sea level pressure in millibars and tenths.

FERO-1 gets it from the observation database looking up to the MSLPres field. Then apply the following procedure to code the pressure because of PPPP has 4 characters.

PPPP:=Mean sea level pressure.
PPPP:=10*PPPP.
If PPPP>=10000 then begin PPPP:= 0(PPPP-10000)
Else PPPP:=PPPP.

5aPPP: Tendency character and amount.

5: Indicator.

a: Characteristic of pressure change.

FERO-1 gets it from the observation database looking up to the Tendency field.

PPP: Pressure change over last three hours in millibars and tenths

FERO-1 gets it from the observation database looking up to the TAmount. Then apply the following procedure to code the tendency amount because of PPP has 3 characters.

PPP:=Tendency amount.
PPP:=PPP*10;
If PPP<10 then PPP:=00PPP.
Else if (PPP>=10) and (PPP<100) then PPP:=0PPP.
Else PPP:=PPP.

6RRRTr: Precipitation

6: Indicator.

RRR: Amount of rainfall in mm

RRR is coded is follow.

001 : 1 mm
002 : 2 mm
...
988 : 988 mm
989 : 989 or more mm
990 – Trace
991 : 0.1 mm
992 : 0.2 mm
...

999 : 0.9 mm.

Tr: Duration of period of RRR in units of six hours. At 0 and 12 GMT Tr :=1 . At 6 and 1800 Tr :=2.

FERO-1 gets rainfall amount from the observation database looking up to the Precip field. FERO-1 finds the Tr variable from the observation time. Then FERO-1 applies the following procedure to code the rainfall amount and Tr together.

```
begin
rr1:=First six hours precipitation.
rr2:=Second six hours precipitation.
GG:=Observation hour.
if (GG=0)or(GG=12) then
 begin
RRR:=rr1.
Tr:=1
 end;
else if (GG=6)or(GG=18) then
begin
RRR:=rr1+rr2;
Tr:=2;
end;
if (RRR<1)and (RRR>=0) then RRRTr:=990+(10*RRR)Tr
else if (RRR>=1) and (RRR<988) then
begin
rrk:=round(RRR);
if rrk<10 then rrk:=00rrk
else if (rrk>9)and (rrk<100)then rrk:=0rrk
else rrk:=rrk
RRRTr:=rrkTr;
end
else RRRTr:=6989Tr
```

end.

7WWW1W2: Present and past weather.

7: Indicator.

WW: Present weather (List of present weather is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the PresentW field. WW must have two characters so; if WW<10 then FERO-1 considers WW as 0WW else considers WW as WW.

W1: First past weather (List of past weather is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the PastW1field.

W2: Second past weather (List of past weather is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the PastW2 field.

8NhClCmCh: Clouds.

8: Indicator.

Nh: Amount of low cloud, or medium cloud if no low cloud present.

FERO-1 gets it from the observation database looking up to the SecCloud field.

Cl: Form of low cloud (List of high clouds is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the LT field.

Cm: Form of medium cloud (List of high clouds is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the MT field.

Ch: Form of high cloud (List of high clouds is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the HT field.

333 : Constant.

1SnTxTxTx: Maximum temperature.

1: Indicator.

Sn: Sign of temperature (0=positive, 1=negative).

TxTxTx: Maximum temperature in tenths of a degree

FERO-1 gets it from the observation database looking up to the MaxTemp field. Then apply the following procedure to code the sign and maximum temperature together. SnTxTxTx must have 4 characters.

TxTxTx:=Maximum temperature.

TxTxTx:=10*TTT.

If (TxTxTx<10) and (TxTxTx>=0) then SnTxTxTx:=000TxTxTx.

Else if (TxTxTx>=10) and (TxTxTx<100)then SnTxTxTx:=00TxTxTx.

Else if (TxTxTx>=100) then SnTxTxTx:=0TxTxTx

Else if (TxTxTx<0) and (TxTxTx>-10) then SnTxTxTx:=100TxTxTx.

Else if (TxTxTx<=-10) and (TxTxTx>-100) then SnTxTxTx:=10TxTxTx.

Else if (TxTxTx<=-100) then SnTxTxTx:=1TxTxTx.

2SnTmTmTm: Minimum temperature.

2: Indicator.

Sn: Sign of temperature (0=positive, 1=negative).

TmTmTm: Minimum temperature in tenths of a degree Celsius

FERO-1 gets it from the observation database looking up to the MinTemp field. Then apply the following procedure to code the sign and minimum temperature together. SnTmTmTm must have 4 characters.

TmTmTm:=Minimum temperature.

TmTmTm:=10*TmTmTm.

If (TmTmTm<10) and (TmTmTm>=0) then SnTmTmTm:=000TmTmTm.

Else if (TmTmTm>=10) and (TmTmTm<100)then SnTmTmTm:=00TmTmTm.

```
Else if (TmTmTm>=100) then SnTmTmTm:=0TmTmTm
Else if (TmTmTm<0) and (TmTmTm>-10) then SnTmTmTm:=100TmTmTm.
Else if (TmTmTm<=-10) and (TmTmTm>-100)then SnTmTmTm:=10TmTmTm.
Else if (TmTmTm<=-100)then SnTmTmTm:=1TmTmTm.
```

3EsnTgTg : Surface.

3: Indicator.

E: State of ground without snow or measurable ice cover (List is given at the database part of FERO-1).

FERO-1 gets it from the observation database looking up to the Surface field.

Sn: Sign of temperature (0=positive, 1=negative).

TgTg: Grass minimum temperature rounded to nearest integer degree.

FERO-1 gets it from the observation database looking up to the SurfTemp field. Then apply the following procedure to code the sign and surface temperature together. SnTgTg must have 3 characters.

```
surf:=Surface temperature.
surfr:=round(surft);
if (surfr<10) and (surfr>=0)then surfr:=00surfr
else if (surfr>=10) and (surfr<100) then surfr:=0surfr
else if (surfr<0) and (surfr>-10) then surfr:=10surfr
else if (surfr<=-10) and (surfr>-100)then surfr:=1surfr
```

4ESSS: Surface.

4: Indicator

E: State of ground with snow or measurable ice cover (List is given at the database part of FERO-1).

FERO-1 gets it from the observation database looking up to the SurfIceSnow field.

SSS: Depth of snow in cm.

FERO-1 gets it from the observation database looking up to the SnowHeight field. Then apply the following procedure to code the snow dept because of SSS has 3 characters.

SSS:=Snow dept.

SSS:=SSS*10;

If SSS<10 then SSS:=00SSS.

Else if (SSS>=10) and (SSS<100) then SSS:=0SSS.

Else SSS:=SSS.

5EEEIe: Evaporation.

5 : Indicator.

EEE: Amount of evaporation.

FERO-1 gets it from the observation database looking up to the Evapo field. Then apply the following procedure to code the snow dept because EEE has 3 characters.

EEE:=Amount of evaporation.

EEE:=EEE*10;

If EEE<10 then EEE:=00EEE.

Else if (EEE>=10) and (EEE<100) then EEE:=0EEE.

Else EEE:=EEE.

Ie: Evaporation type.

FERO-1 gets this value from the station information form. It is 4 at meteorological stations in Turkey.

55sss: Sunshine.

55: Indicator.

sss: Duration of sunshine in hour and tenths.

FERO-1 gets it from the observation database looking up to the SunShine field. Then apply the following procedure to code the snow dept because sss has 3 characters.

sss:= Duration of sunshine.

sss:=sss*10;

If sss<10 then sss:=00sss.

Else if (sss>=10) and (sss<100) then sss:=0sss.

Else sss:=sss.

J5F24F24F24: Radiation

J5: Radiation type.

FERO-1 gets this value from the station information form. It is 2 at meteorological stations in Turkey.

F24F24F24: Radiation amount in joule/cm^2.

FERO-1 gets it from the observation database looking up to the Radiation field. Then apply the following procedure to code the snow dept because F24F24F24F24 has 4 characters.

ra:= Amount of radiation.

rad:=round(10*ra*4.1868)

if (rad<10) and (rad>=0)then rad:=000rad

else if (rad>=10)and (rad<100)then rads:=00rad

else if (rad>=100)and (rad<1000)then rads:=0rad

else if (rad>=1000)then rad:=rad

F24F24F24F24:=rad.

7R24R24R24R24: Daily precipitation.

7: Indicator.

R24R24R24R24: Amount of daily precipitation.

FERO-1 gets it from the observation database looking up to the Radiation field. Then apply the following procedure to code the snow dept because R24R24R24R24 has 4 characters.

```
top:= Amount of daily precipitation.
top:=10*top;
if (top<10) and (top>=0)then top:=000top
else if (top>=10)and (top<100)then top:=00top
else if (top>=100)and (top<1000)then top:=0+top
else if (top>=1000)then top:=top
R24R24R24R24:=top
```

8NsChshs: Clouds.

8: Indicator

Ns: Amount of individual cloud layer

FERO-1 gets it from the observation database looking up to the CCN, LCN, MCN and HCN fields.

C: Form of cloud (List of clouds is given at database part of FERO-1).

FERO-1 gets it from the observation database looking up to the CCT, LCT, MCT and HCT fields.

Hshs: Height of base of cloud layer

FERO-1 gets it from the observation database looking up to the CCH, LCH, MCH and HCH fields.

910ff: Gust.

910: Indicator.

ff: Amount of gust in knots.

FERO-1 gets it from the observation database looking up to the Gust field. ff must have two characters so; if ff<10 then FERO-1 considers ff as 0ff else considers ff as ff.

924SVs: Sea status.

924: Indicator.

S: Sea status.

FERO-1 gets it from the observation database looking up to the SeaStatus field.

Vs: Sea visibility indicator.

FERO-1 gets it from the observation database looking up to the SeaVis field.

931ss: Fresh snow.

931: Indicator.

ss: Height of fresh snow in cm.

FERO-1 gets it from the observation database looking up to the NSHeight field. ss must have two characters so; if ss<10 then FERO-1 considers ss as 0ss else considers ss as ss.

960ww: Second present weather.

960: Indicator.

ww: Second present weather.

FERO-1 gets it from the observation database looking up to the PresentW2 field. ww must have two characters so; if ww<10 then FERO-1 considers ww as 0ww else considers ww as ww.

555 : Constant.

0snTwTwTw: Sea temperature.

0: Indicator.

Sn: Sign of temperature

TwTwTw: Sea temperature in tenths of a degree.

FERO-1 gets it from the observation database looking up to the SeaTemp field. Then apply the following procedure to code the sea temperature because TwTwTw has 3 characters.

TwTwTw:= Sea Temprerature.

TwTwTw:=TwTwTw*10;

If TwTwTw<10 then TwTwTw:=00TwTwTw.

Else if (TwTwTw>=10) and (TwTwTw<100) then TwTwTw:=0TwTwTw.

Else TwTwTw:=TwTwTw.

SN: Station name.

FERO-1 get this value from the station information form.

Azami:: Constant.

Asgari:: Constant

= : Constant.

3.2.9 DAILY EXTREMES MENU

At the end of the day, observers have to find the extreme values of some meteorological parameters. Also, they must find the observation times of these parameters. Observers do this job manually by comparing 24 hours records. It is possible to make mistakes while finding the time of the extreme values.

This menu helps users to find the daily maximum and minimum values of temperature, humidity, pressure and water vapour pressure and wind speed. After finding the maximum or the minimum value FERO-1 finds the time of these values.

FERO-1 follows the following procedure to find the extreme values.

1. If any button that represents the meteorological parameter clicked then open the database.
2. Go to the last record and read the value at the day field.
3. Go the first record of the last day.
4. Create 3 arrays.
5. Begin to read all the observation records of the clicked parameter from the beginning hour to the last hour of the day.
6. Set all these values into the first array.

7. Apply the 'finding biggest' algorithm to the first array to find the maximum value of the parameter.
8. Apply the 'finding smallest' algorithm to the first array to find the minimum value of the parameter.
9. Begin the compare the biggest value and all other values in the first array. If there is same value with the biggest value then set the value of the hour field of this record into the second array.
10. Begin the compare the smallest value and all other values in the first array. If there is same value with the smallest value then set the value of the hour field of this record into third array.
11. Write the biggest value into the edit menu of the parameter under the maximum label.
12. Write all values that are in the second array after the biggest value.
13. Write the smallest value into the edit menu of the parameter under the minimum label.
14. Write all values that are in the third array after the smallest value.

CHAPTER FOUR
USER MANUAL FOR FERO-1

4.1 USER MANUEL FOR FERO-1

This part of the thesis shows how an observer can use FERO-1. The screen shots of the FERO-1 are use to show the real system. Menus of the system have small descriptions with their screen shots. All examples were chosen from the real world data. Izmir Meteorological Weather Service was used for the meteorological station. The observations values of first and second days of the March month were used to operate the database of FERO-1. An example for observation coding firstly shows the parameters to be filled on the observation forms then shows the fields of the observation record of the database and finally shows the coded observations. There can be values of the meteorological parameters at the database but same parameters cannot be seen on the observation forms. This means that FERO-1 calculated all values automatically.

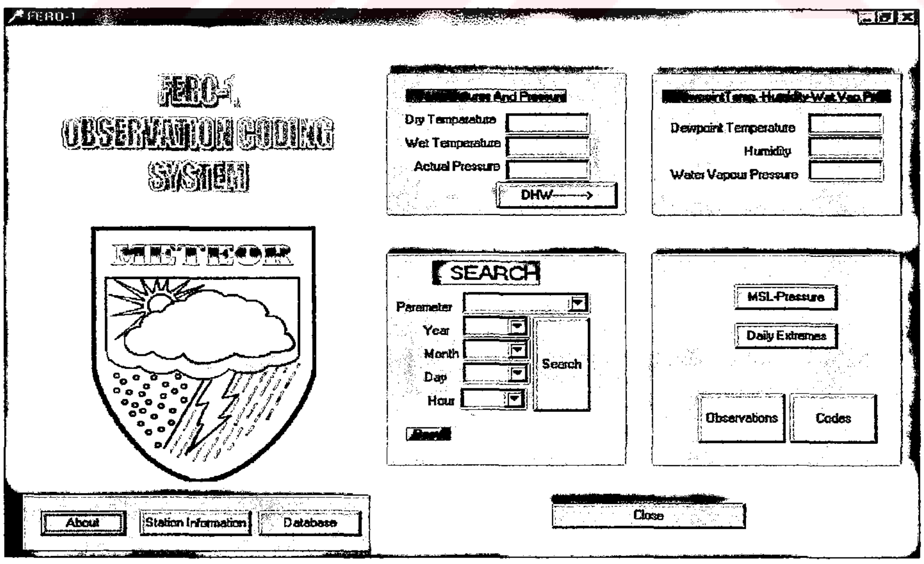

Figure 4.1 Main observation menu.

To see the information about implementer and Produce date of FERO-1 click the 'About button'.

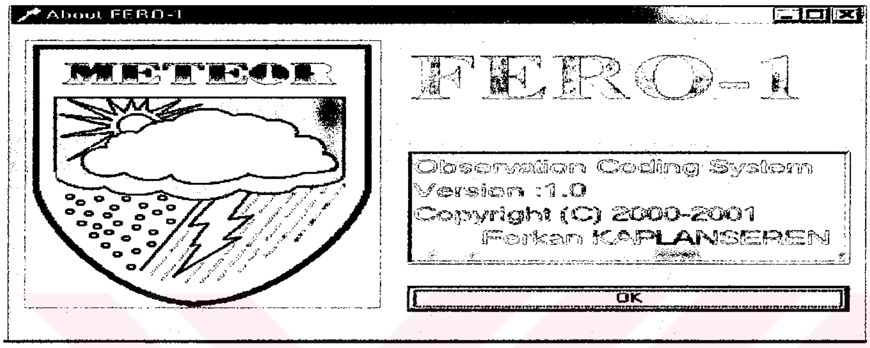

Figure 4.2 About menu.

To get information about the station information or to change the station information click the Station Information button.

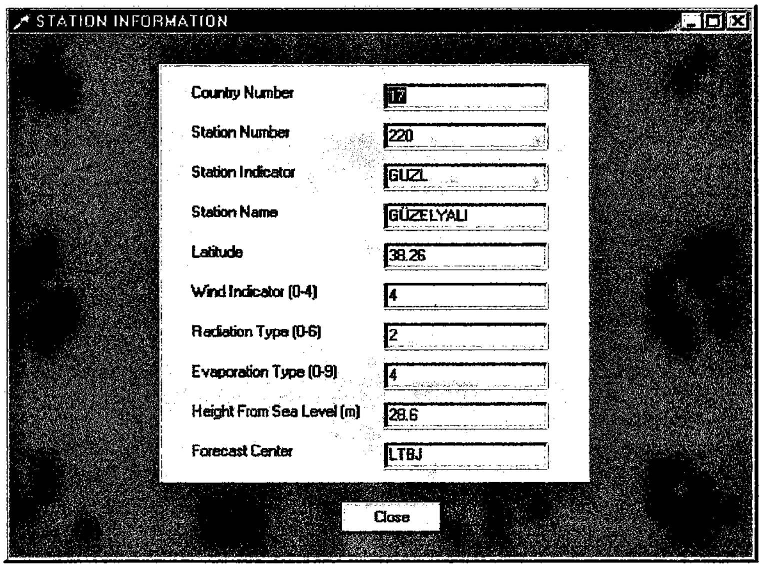

Figure 4.3 Station information menu.

After pressing close button you see a dialog box warning if you are sure to change the information about station.

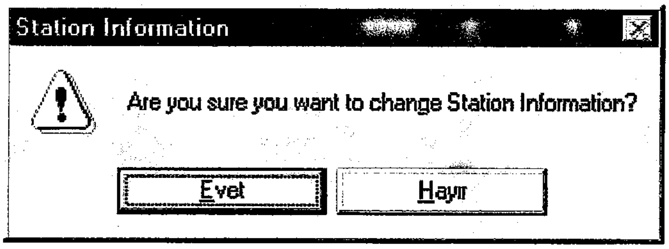

Figure 4.4 Dialog box of Station Information.

To calculate the Dew point temperature, Humidity an Water vapour pressure, fill the dry temperature, wet temperature and pressure edit menus and then click DHW button. If FERO-1 opens a message box, apply the written message.

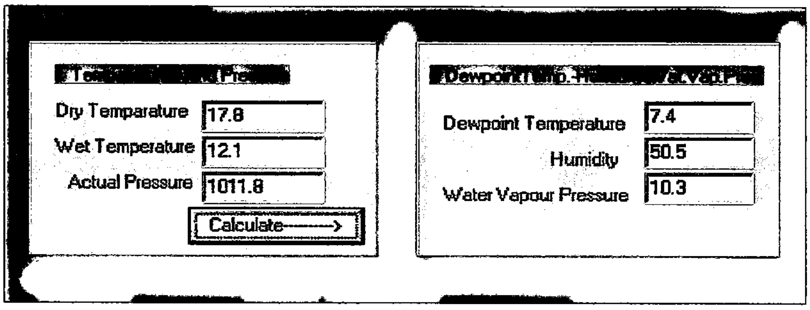

Figure 4.5 DHW procedure.

To search the database, fill the parameter, year, month, day and hour combo box menus and then click DHW button.

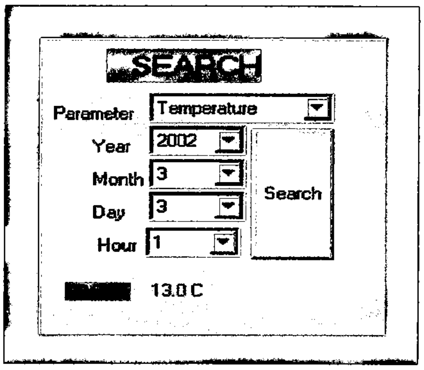

Figure 4.6 Search procedure.

To calculate the actual pressure and the mean sea level pressure fill the barometer pressure, barometer temperature, dry temperature, temperature 12 hours ago and humidity edit menus and then click the MSL-Pressure button.

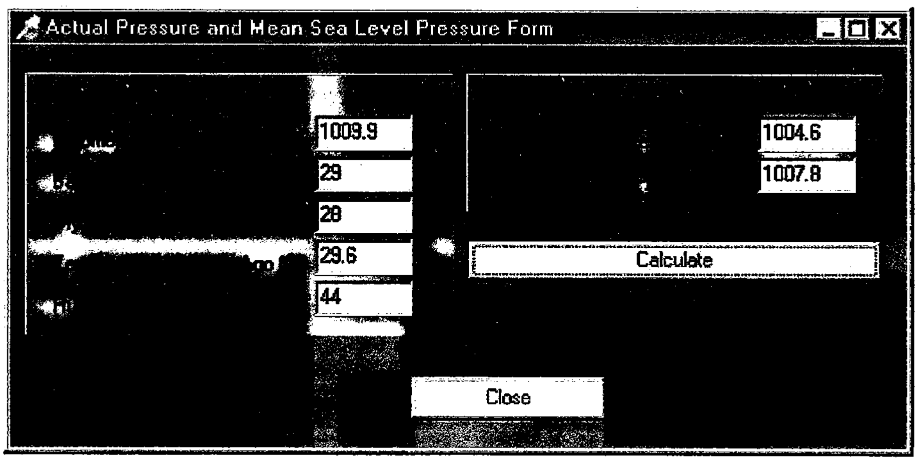

Figure 4.7 MSL-Pressure procedure.

To find the daily extremes click the daily extremes button. To find the maximum and the minimum values and the GMT time of the observation click the buttons on the left side of the form. For this example, the values between the 0 GMT and 7 GMT are studied and the results are on the screen shot.

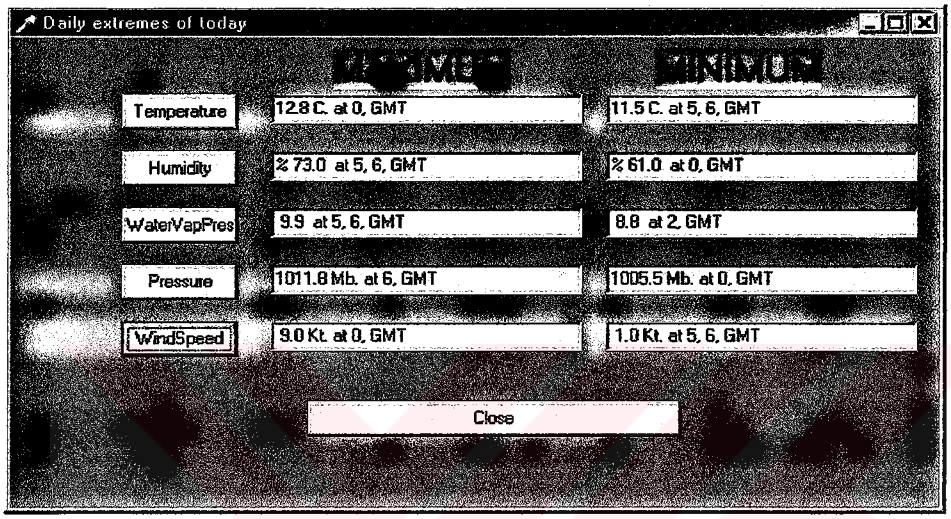

Figure 4.8 Daily extremes.

To record the observation values click the observation button. FERO-1 opens you a observation that is needed for that hour. The simplest form is the hourly observation form.

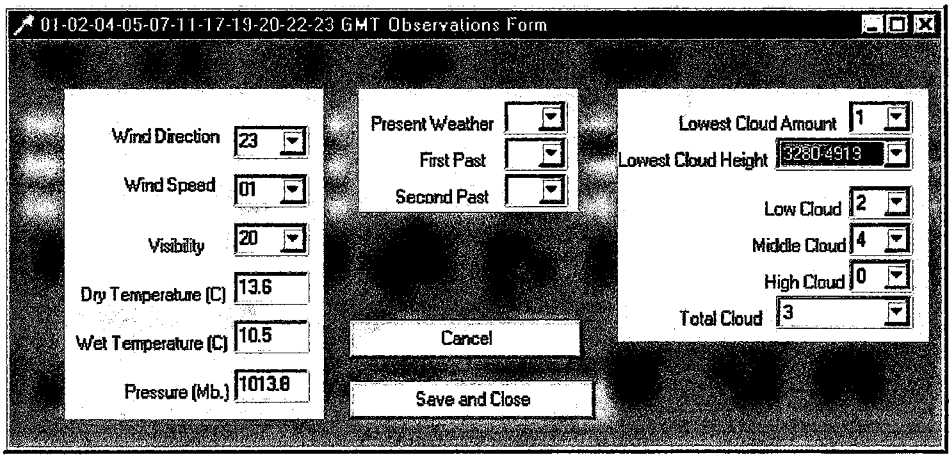

Figure 4.9 Observation form for hourly synop observations.

To see the values entered into the observation form at the database click the database button. You can reach to any record by filling the year, month, day and hour combo box menus and then clicking the 'go' button. Also you can use the database navigator and arrows to reach any record.

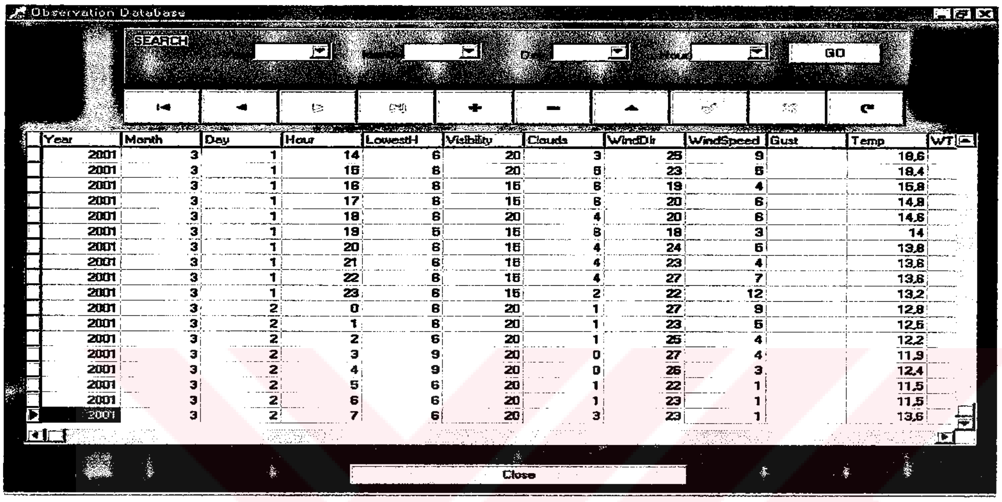

Figure 4.10 Database of FERO-1.

To code the observation, click the Codes button. You can choose synop button to code observation. If you click other observation buttons now, you will get a message that, this is not the observation for this type. Also you can add requests to the editor.

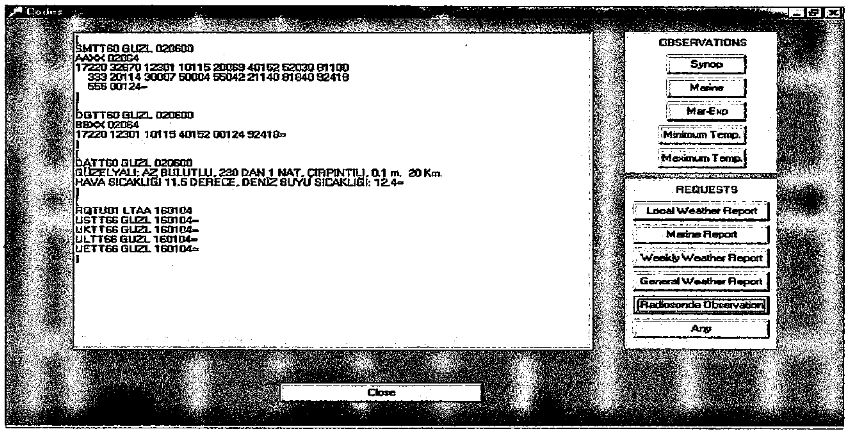

Figure 4.11 Coding part of FERO-1.

CONCLUSIONS

FERO-1 is designed to give alternative opportunities about fast and correct coding to the observers working at the meteorological stations in Turkey. FERO-1 is designed as an information system, which collects the data, manages the data and by processing data, prepares codes for the synoptic and marine observations. FERO-1 is especially designed for the observations at Izmir meteorological station.

It is decided that three main subjects are important for FERO-1, they are Friendship, Quality Control and Database. So FERO-1 introduces some facilities to users related to these three subjects. They are: Using windows operating system, having quality control, database and search procedure.

FERO-1 was run on a computer at Izmir Meteorology Service for ten days. All observations are coded at the same time with the other system MIVIP. Ten days later it was good to see the all information, which is entered into the database of FERO-1. Also ten days later the advantages of FERO-1 could be seen clearly. The main advantages of FERO-1 can be listed as follow:

1. FERO-1 runs under windows operating system. So, it easy to use it.
2. FERO-1 automatically prepares the observation forms and never wants user to choose the observation type. So, users do not think what kind of observations is prepared for any hour.
3. The observation forms never include unnecessary meteorological parameters. So users never fill unnecessary parameters.
4. FERO-1 controls the values that are entered into the observation form if they are correct or not. Users are warned against to the mistakes.

5. FERO-1 not only sends the information from the observation form into the database, it also calculates some variables and sets them into the appropriated fields.
6. From now on the synoptic observation information will not lost. They will be kept in the database and would be used for any study.
7. Users can search the database and can reach the information any time.
8. The third (Actual Pressure) group never added into the synoptic code. So user never has to delete this group for every synoptic code.
9. The fifth group including the pressure tendency and amount of pressure difference is automatically calculated and added to code. For that reason observers are prevented to calculate wrong tendency type and wrong pressure difference. User never looses time for fifth group.
10. Marine observation codes are prepared automatically with the synoptic observation codes. So user never enters the same values for marine observation code.
11. Marine explanation observation codes are prepared with the marine observation codes. User never writes the all code manually onto the editor.
12. User never writes the temperature codes manually.
13. FERO-1 makes observers to do their works faster.
14. User never writes the request codes manually. FERO-1 prepares them according to the computer time.

For the future work, FERO-1 can be improved in details. It can be designed for all types of observations. Its database again may be designed more effectively for the other observations. Except being a system for observers it can also be used by people directly. Some other studies can be done at the end of the day or at the end of the month. For example, graphics of meteorological parameters can be prepared, monthly averages can be calculated etc. All these properties and database may be shown from the Internet to everybody. Ideally weather forecast can be added into FERO-1 system.

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APPENDIX A

These comments were taken from the personnel working at Izmir Meteorological Service on 12 July 2001 at the meeting room of İzmir Meteorological Service after a short presentation for FERO-1 system.

1- Şube müdürlüğümüzde kullanım kolaylığı ve en önemlisi kalite kontrolden geçmiş bilgilerin arşivlenmesine imkan veren bu program, çalışan personel açısından yararlı olacaktır.

Başarılı çalışmalarının devamını dilerim.

Aysel MUNGAN
Meteoroloji Bölge Müdürlüğü
Teknik Şube Müdürü

2- FERO-1, halen kullanmakta olduğumuz MIVIP programına göre oldukça iyi ve gelişmiş bir program. Hem rasat hatalarını engelleyici hem de zaman tasarrufu sağlayıcı bir program olmuş. 24 saat bu işi yapan personel için büyük bir kolaylık ve hataya karşı önemli bir güvenlik sağlayacak. Günümüz şartlarında rasat hazırlama ve göndermeye yönelik bir programın yapılması çok zor. Programı yapana ve destekleyenlere şimdiden çok teşekkür ederiz.

Yusuf BAKAN	Yaşar KARADAĞ	Gökhan ERTÜRK.
Teknik Birim Sorumlusu,	D ekip Şefi,	Haberleşme Teknisyeni-Rasatçı

3- Kullanılmakta olan MIVIP programındaki rasat kodlama, şüphesiz yazıldığı zaman önemli bir açığı kapatmıştı. Bilgisayar hızı ve kapasitesinin düşüklüğü, bu programının kapsamının dar tutulmasına neden olmuş, kodlama sırasında veri saklamadığı için kodlamada operatör hatalarının önüne geçilememiştir.

Gelişen teknolojiye bağlı olarak verinin sakladığı ve rasat kodlama sırasında tekrar kullanıldığı, farklı rasatlarda kullanılan verilerin tekrar tekrar girilmediği, daha kapsamlı bir kodlama programına gereksinim vardı. FERO-1 kodlama sırasında operatör hatalarını ortadan kaldıracak şekilde yazıldığı için bu gereksinimi karşılayacaktır.

Tufan YÜKSEL
Ekonomist-Bilgi İşlem Sorumlusu

4- Meteorolojide rasat kodlamak için halen MIVIP programını kullanmaktayız. FERO-1 programını rasat kodlarken kullanıcıya getirdiği kolaylık, hem kendi içinde yaptığı kontrol ile hatalı veri girilmesini önlemesiyle, hem de geçmişe ait verilerin saklanabiliyor olmasıyla MIVIP programına göre oldukça gelişmiş ve kullanışlı bir program olarak değerlendirmekteyim.

Ferkan KAPLANSEREN'i bu güzel çalışmasından dolayı kutlarım.

Gülden BOZCA
Meteoroloji Mühendisi

5- FERO-1 programı bugüne kadar kullanılan programlarla mukayese edilemeyecek kadar mükemmel, kullanışlı ve pratik olduğu kanısındayım. Meteoroloji camiası için yararlı olacağını düşünüyorum.

E. Cansın YAYAN
Ziraat Mühendisi-İstidlalci

6- FERO-1, uzun yıllar meteoroloji istasyonlarında gözlem yapmış olmanın verdiği deneyimle, matematik altyapısının gerektirdiği, sonuca kestirmeden, zahmetsizce ulaşılmasını sağlayacak şekilde yapılmış, meteoroloji istasyonlarındaki kodlamadan kaynaklanan hataları sıfıra indirebilecek, yapılan işlerde zaman kazandıracak ve belki de en önemlisi girilen bilgileri arşivleyip istenildiği anda ulaşılmasını sağlayacak bir program olmuş.

Ersel ŞENGEL
Şef İstidlalci

7- Bu program gerek kullanım kolaylığı, gerek ekran dizaynı ve gerek işlevleri açısından mevcut kullanmakta olduğumuz programın çok ileri bir aşamasıdır. İnancım odur ki bundan sonraki çalışmalar (istatistiki açıdan) yapılan FERO-1 programı üzerine inşa edilecektir.

Dr. İsmail ARSEL
Fizik yüksek Mühendisi