

Application of monitoring and controlling system of Beidou-1 system in transportation of dangerous chemicals

Jing Zhang¹, Zhonghua Li², Yaoqiu Wang¹

¹ Department of Logistics management, Beijing Jiao tong University, China
jzhang@bjtu.edu.cn, yqwang@bjtu.edu.cn

² Chinese Academy of Sciences, Institute of Geodesy and Geophysics, China
zhonghua@asch.whigg.ac.cn

Abstract: With the rapid development of China economy, the demands of chemical energy are growing rapidly and the highway traffic of dangerous chemicals is increasing dramatically. Based on these situations, this paper presents that applying the monitoring and controlling system of BeiDou-1 to solve the safety problems in the transportation of dangerous chemicals. This paper firstly gives a presentation of the monitoring and controlling system of BeiDou-1, and then analyses the factors which result in accidents of the transportation of dangerous chemicals. Finally, we provide some idiographic solutions which include accident alarm, reducing the probability of traffic accident and the emergency solutions to accidents and so on. These solutions incarnate the position and communication functions of the system and it also incarnate the characteristics of the system in high reliability, flexible service manner, safety, and stability, good confidential and reasonable cost and so on.

Keywords: BeiDou-1 System, Monitoring and Controlling System, Transportation of Dangerous Chemicals, Accident Alarm, Emergency Controlling System

1. Introduction

With the fast development of China's national economic construction and national defense, the demands of chemical energy are growing rapidly and the highway traffic of dangerous chemicals is increasing dramatically. Currently, vehicle for dangerous chemicals has reached several hundred thousand in China, and the rising accidents of the transportation of dangerous chemicals have

brought great loss and dangerousness to the people's lives and property. Although the energy have brought great convenience to the production and live, they also have brought enormous environmental threats which cannot be overlooked. So far there has not yet very effective means to systematically address the early warning of security and the handling of emergency and the transport accidents of dangerous chemicals still not been very effectively restrained. Therefore, in order to solve the current problem of dangerous chemicals transportation security, the modern means of high technology should be used to establish a comprehensive monitoring and controlling system of dangerous chemicals transport.

With a strong technology platform, BeiDou-1 system have many characters: accurate positioning, Bidirectional Communication and precision timing, along with independent positioning and communication functions; it has a wide coverage with no-blind zone communication; equipments used by custom are simple and have high reliabilities; the service is flexible and manifold connect manner is optional. It is suitable to applicant for key sectors for its safe and stable, confidential and cost reasonable. According to the rules of market economy, "combining the military to the people", "peacetime with wartime", and basing on the full understanding and grasp of dangerous chemicals transport industry, we should make an integration of resources, establish a new transportation of dangerous chemicals and monitoring and controlling system and promote the civil industry process of BeiDou-1 system.

Then, how does BeiDou-1 system work in the monitoring and controlling system? In the following part, we will first introduce the principles and characters of the "BeiDou-1 satellite navigation systems", and then we will give a description of the monitoring and controlling system of dangerous chemicals transport ,and the last is the solution for problems basing on the cases of new system and the accident analysis.

2. Components, Functions and Characteristics of Beidou-1 System

2.1 Components

BeiDou-1 system is a local navigation system developed by China, which can provide satellite navigation information all-weather and all time. The system is composed of space satellites, ground control station (GCS) and BeiDou-1 user terminal. The space segment includes geosynchronous (GEO) satellites and medium earth orbit (MEO) satellites, and the currently completed project of

BeiDou-1 includes two GEO satellites. The Satellite has transponder signal devices which can complete the two-way radio signal relay task between GCS stations and user terminal. Contract with GPS systems, the calculation of all user terminals are completed in the GCS. Therefore, the location and time information of all BeiDou-1 end-users can be retained by the GCS. At the same time, the GCS is also responsible for monitoring and managing the whole system. A user terminal is used by users directly to receive Ranging Signal transponder from GCS. According to the implementation of different tasks, the user terminal is divided into positioning communication terminal, corporate customer center terminal, differential terminal and time calibration terminal.

2.2 Three Major Functions of Beidou-1

Rapid positioning: The BeiDou-1 navigation system can provide users within the service area with all-day, high-precision and fast real-time location-based services.

Brief communication: The BeiDou-1 system user terminal has a capability of two-way digital communications to deliver the information up to 120 Chinese characters by registered users in the manner of continuous transmission.

Precision Timing: The BeiDou-1 system has a timing function of one-way or two-way to complete the time and frequency synchronization between the timing terminals and BeiDou with 100 ns (one-way award) and 20 ns (two-way granted) required on the accuracy.

2.3 Characters of Beidou-1

Independent: The system such as GPS, GLONASS can be used by China in peacetime, but there will be a significant risk in wartime. The control rights and the initiative of the BeiDou-1 system are established independently by china.

Integration of positioning, communication and timing: BeiDou-1 has not only the abilities of positioning and timing, but also a function of data Communication.

Reporting the user-position: The reports of users position will be completed at the same time of positioning to real-time Schedule for the command or group users.

Positioning fast at the first time: At present, foreign satellite navigation positioning system (SNPS) at least need ten seconds from the boot to obtain location information. BeiDou-1 user machines can be completed positioning within 3 seconds, it is the world's first fastest positioning satellite navigation and positioning system.

3. Components and Functions of Dangerous Chemicals Transportation Monitoring and Controlling System

3.1 Components

The dangerous chemicals transportation monitoring and controlling system based on BeiDou-1 satellite can effectively prevent the occurrence of the dangerous chemicals transportation accident, timely warn the potential security problems and remove it, minimize the accident probability and rapidly implement emergency measures after the accident. The system consists of three parts: work condition information central collecting and vehicle control processing, satellite positioning and communication transmission, and control command center.

Work condition information central collecting and vehicle control processing:

Work condition information central collecting and vehicle control processing is divided into three aspects: the head, the walking part and the tank. There are total of eight collecting points including: driven route, internal temperature and pressure of tank, fingerprint identify, speed, continuous driving time, brake pressure, and tire pressure.

After signal conversing to be unified standard format, the work condition data corresponding vehicle collected by the distribution sensor has been summarized to the terminal of vehicle work condition information central collecting and vehicle control processing, which then deal these data with processing, compression, encryption, caching, and transmitting to the part of satellite positioning or communication transmission on the requiring.

Vehicle control is operation control terminals part of the driver, including liquid crystal faceplate (LCD), function operate key and the emergency handle, to complete the emergency alarm, built-in messages sent, vehicle information inquiry and sound prompt.

The vehicle control module set up criticality alarm scope to automatic alarm drivers the anomaly information according to the collecting information, and at the same time the abnormal information will be automatically exported to satellite positioning and communication transmission part, through which the command center master the abnormal state of the vehicle at the same time and then remote command the abnormal vehicles with control measures. the control command has been captured, analyzed and validated by the vehicle work condition information collecting part, and the corresponding measures has been taken to prevent the accident.

Once the accident occurred, the system will take self-help measures to automatic off the vehicle, and open all the doors to facilitate the driver with timely evacuating accident scene. At the same time, the dark casket of the vehicle work condition information collecting part can provide reliable information for the cause investigation of the accident, that is, according to the instructions of the monitoring command center, the data of pre-accident 30 s can be transmitted to the command center for analysis and monitoring evidence. The components of dangerous chemicals transportation monitoring and controlling system is shown in figure 1.

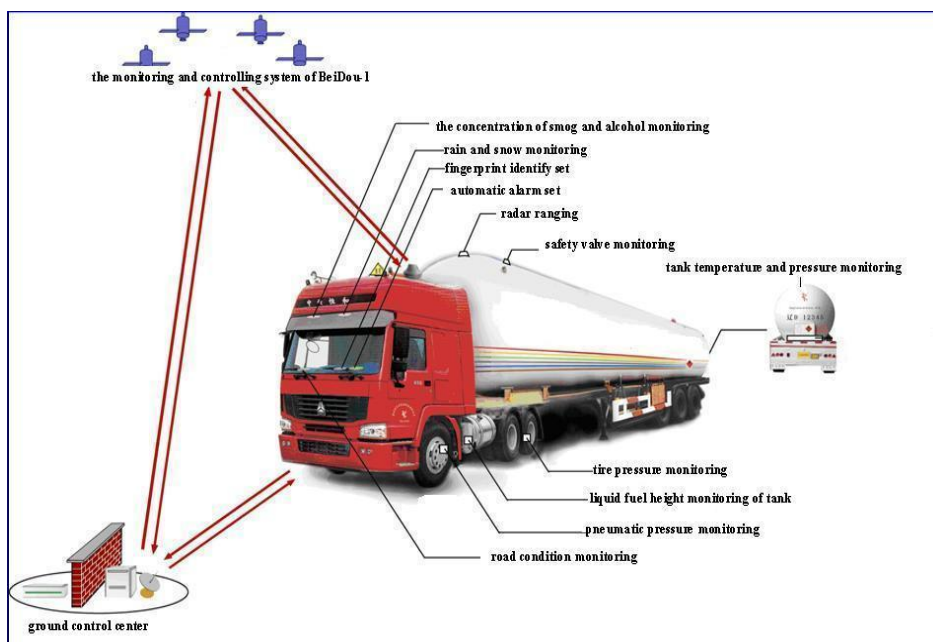


Figure 1: The components of dangerous chemicals transportation monitoring and controlling system

Satellite positioning and communication transmission:

Different from any location transmission equipment, as the link of the command center and the vehicles, the satellite positioning and communication transmission is an important core independent researching and developing of the system. It is dual-mode positioning transmission equipment composed of BeiDou-1 RF communication module and GPS.

The monitoring command center:

The monitoring command center is the central organ for the dangerous chemicals transportation monitoring and controlling system's operation, also is the "telescope" to understand the vehicles and is the "punches " to remote

control the vehicles for the management. The center can monitor the position and state of the vehicle, provide early warning information, location inquiries, vehicle management, information and other interactive services for the supervision and management departments, support the remote scheduling and major decisions with data to reduce accident probability, and at the same time, also can rapidly organize emergency rescue work through the linkage network with various departments in charge.

The monitoring command center can conduct real-time information interaction with vehicles through the part of communication network system. In the normal transport conditions, the vehicle's track and condition information does not display excluding designated vehicle. In an emergency situation, the vehicle control unit captures the unusual information, and automatic sent the data of vehicle location and abnormal information to the monitoring control center until the hazardous lifting. As a backup means, a manual alarm functions also be provided by the vehicle. At the same time, the data information sharing with other remote monitoring nodes is supported in the authorized scope by the monitoring command center. By the way of VPN, the interconnection and interoperability have been achieved within the scope of authorized among the monitoring command center, the monitoring command sub-center, and the department monitoring command center. The monitoring command center is shown in figure 2.

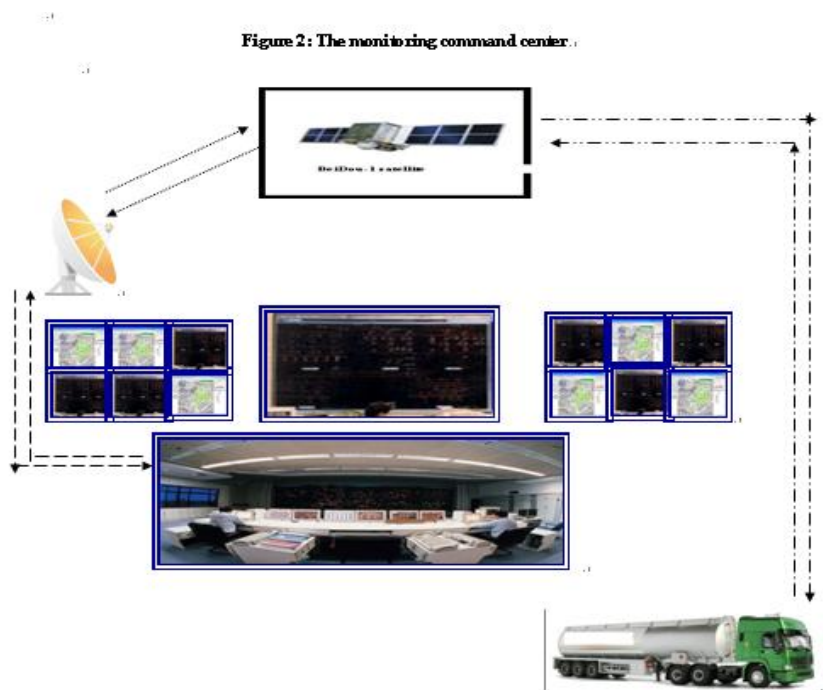


Figure 2: The monitoring command center

3.2 The Main Functions of the Monitoring Command Center

Electronic map roaming and geographical data calculation:

The electronic map of the monitoring command center use a map about 1:250000 of whole factor map nested and 1:10000 of prefecture-level cities (including the above) to provide operational function of the electronic map relevant and such auxiliary function of area and length measurement.

Vehicle routing planning:

The dynamic and visual routing based on the electronic map can be planned by the monitoring command center, and the configuration routing data can be sent to the automotive systems to control online vehicles traveling on designated routing. Once the controlled vehicles deviating from the designated routing, or driver speeding, or driving overtime, the system alarms automatically in voice.

Transmission and broadcast messages:

The monitoring command centre will not only receive text messages of automotive terminals, but also sent the inputted message to the vehicle terminal, and at the same time broadcast to many or the whole vehicle team.

Historical data retrospective:

The monitoring command centre can play back a/a group of or vehicles historical data in the electronic map on track, and supports the enquiries and print output of vehicle information.

Data distribution and transmission:

Multi-level monitoring command centre have been build. Data distribution has been supported and monitoring the sharing of information between nodes can be authorized among the command centers.

Emergency handling:

In the vehicle confirmed the existence of potential hazards or police information occurred, the command centre can handle the emergency through the vehicle terminal.

Communication:

Under exceptional circumstances, the drivers can directly communication with the monitoring command centre through the car-talk call to understand the real-time situation.

4. Accident Cases Analysis and Solutions

The accident cases are: dangerous chemicals transportation vehicles not in specified routing; the internal temperature and pressure of tank are super-standard; non-qualified driver driving; speeding, drowsy driving, braking failure, tire puncture. Then, combining the specific accident cases, practical early warning solution can be proposed through analyzing the reasons of the accident.

Driving not in specified routing, and bumpy road caused accident that tank lorry ball valves ruptured:

Specifying routing and alarm in deviation. When the vehicle deviating from the specified routing in the transport of the dangerous chemicals, the vehicle system can independently voice warns the vehicle according the positioning information and the pre-set routing. At the same time, the unusual circumstances of vehicle can be automatically discovered by the monitoring command centre and to be displayed on the big screen. Then, the correct routing will be suggested to the driver through the monitoring command centre and vehicle information central collecting and vehicle control processing system.

Information collection of the internal temperature and pressure of the dangerous chemicals vehicle tank and early-warning:

Tank temperature and pressure information collecting. The data collected from the sensor of pressure and temperature will be automatically stored in the vehicle terminal. Voice alarm when super-standard occurred and being

transmitted to the monitoring command centre for judgment through BeiDou-1 satellite to avoid accidents.

Non-qualified drivers causing the dangerous chemicals transportation accidents:

Fingerprint Matching confirmed driving staff. In order to prevent illegal driving, the fingerprint recognition system has been used to validate the driver's identification. A unique ID stored in the database of the monitoring command centre corresponding to personnel files will be assigned for each driver. In the vehicle terminal, the fingerprint feature after authenticating and the corresponding driver ID corresponding to keep in the database of vehicle fingerprint identification system, thereby the communicating pressure of the wireless communication terminals has been reduced the of only after the local authentication and without remote authentication.

Speeding, vehicle chasing offal and side turning over accident:

Speeding monitoring: The data of speed collected real-time will be automatically stored in the vehicle terminal. Voice Alarm when speeding occurred and being transmitted to the monitoring command centre for judgment through BeiDou-1 satellite to avoid accidents.

Drowsy driving caused traffic accidents:

Drowsy driving controlling: The drivers will have fatigue after continuous driving four hours. In order to avoid the resulting traffic accidents, the driving records of more than four hours driving without parking break will be automatically deposited on terminal equipment. Voice Alarm and being transmitted to the monitoring command centre through BeiDou-1 satellite to monitor the driver's behavior.

Inadequate brake pressures caused traffic accidents:

Pneumatic pressure checking: When the pressure value of each vehicle brake reading through CAN (Controller Area Net) bus is less than the critical value, the voice prompt driver and at the same time, the data are automatically stored and being transmitted to the monitoring command centre.

Tires abnormal pressure caused vehicle accidents:

Tire pressure monitoring. The tire pressure has been monitoring in real-time by the pressure sensor. Voice alarm alert when abnormal occurred and the data will be automatically stored in the vehicle terminal and being transmitted to the monitoring command centre through BeiDou-1 satellite for taking timely remedial measures.

To sum up, this system take full advantage of the characteristics of BeiDou-1 satellite systems with the position report, security, and reliable communications,

and realize the two-way transmission of the monitoring and command information of the dangerous chemicals vehicle condition. With the application and development in the civilian system of BeiDou-1 system, the tremendous advantages have been demonstrated than the GPS system. The multi-functional needs of many groups about command mobilization, information transceiver, communications etc cannot be fully satisfied by a single position report of such as GPS. In the use of BeiDou-1 about information receiving, information processing, user managing, monitoring commanding, command reporting, information disseminating, and its position reporting and communication technology platform, and further integrating the resources of wireless communications and internet, and making greater perfect positing services, and gradually establishing a comprehensive service system, the solution with full function, fine and appropriating can be provided for kinds of industry users. Therefore, it is the best solution in modern dangerous chemicals transportation monitoring and controlling system in use of BeiDou-1 navigation and positioning system technology and integrating GIS technology. That is in addition to further achieve information and electron, has also reinforced its messages transmitting and visualization functions.

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