
**OPERATIONAL AND ENGINEERING
EMERGENCIES MANAGEMENT ON FEDERAL ROAD
BR-277/PR, SECTION CURITIBA-PARANAGUÁ
(BRAZIL)**

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SUMMARY

Abstract

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ABSTRACT

This technical paper's objective is to present the evolution occurred on managing operational and engineering emergencies on road BR-277/PR (Brazil). The adopted procedures, from different times, have been described in order to cover several emergency situations. Results reached throughout the years and future actions and measures have also been described, showing how the concession company achieved/created them using the acquired experience.

Keywords: Road emergencies management

1. ROAD HISTORY

This section of road BR-277 was implemented with the objective of being an alternative to the railroad transportation that existed between Curitiba and Paranaguá since the end of 19th century. Its implementation occurred in 1946, although its adequate paving only occurred between 1967 e 1968. In terms of altimetric variation, the road develops itself between quota 908m, in the city of Curitiba, to quota 2m, since its final point is located near the port in Paranaguá, even so, in the region in the crossing of the Serra do Mar it reaches quota 1100m. The total extension executed was 85,7 km, being able to be divided in 3 segments, considering topographic aspects, to be known: i) Segment between km 85,7 and km 60,0, with an extension of 25,7km, which is denominated plateau (Planalto, in Portuguese), ii) Segment between km 60,0 and km 31,2 with an extension of 28,8km, known as mountain ridge segment (Serra, in Portuguese) e iii) Segment between km 31,2 and km 0,0, with an extension of 31,2km, denominated plain (Planície, in Portuguese). The structure established consisted in a simple track with 2 traffic lanes, each one with 3,6m and paved shoulder in each side of the traffic lanes with a width of 2,5m. Alongside its trace, although it develops itself in different place near the mountainous region, it haven't been built any tunnels, however there was a necessity of implementation of 2 viaducts to surpass a slope that present an very high transversal inclination e whose landfills probably would have big heights. The pavement structure was executed with a layer of bituminous concrete of 10cm, foundation/sub-foundation with assorted materials and thickness alongside the section with the utilization of bituminous macadam, soil with crushed stone and soil cement.

With an increase in the traffic volume through the years, the DNER (DNER - Departamento Nacional de Estradas de Rodagem, in Portuguese – In English: National Department of Main Roads) hired a project to duplicate this segment. The Studies and Projects were developed in 1974 and conducted the definition that a new track should be sometimes implemented in the existing road's left side, and sometimes in the right side due to the region's topographic characteristics, especially in those segments, which had been implemented in half hillside creating situations of mixed session in cut and landfill. This option allowed rationalizing the cost of duplication, resulting in a smaller volume of earthwork and reduction in the extension of special art and contention works. Implementation works of the new track and restoration of the old track started in 1976 e were finished in 1981.

After the implementation of the track duplication and the existing track's restoration, the road displayed a good behavior in its infra and super structure during some years (between 1981 and 1988), however the heavy traffic and nature's agents actions combined with lack of conservation and maintenance started a process of degradation that obliged the DNER to hire a simplified project, executed in 1989. From project few solution were implemented, which resulted into deterioration of the road body.

In December 1997 this section had its administration addicted to private initiative in a 24-year concession, what gave origin to the concessionary ECOVIA. This company is controlled by Group Primav Ecorodovias S.A. The group's stockholding composition is 65% from Group CR Almeida (Brazil) and 35% from Impregilo IINV (Italy).

2. ROAD EMERGENCIES MANAGEMENT HISTORY

Since the road was open to vehicle traffic and until it was handed to a concession company, the emergencies management was held by DNER, which executed necessary actions assisted by Federal Road Police, Paraná's Environmental Institute, State Fire Department, Public Hospitals and conservation and maintenance companies hired to perform this kind of tasks.

At times, the services performed didn't fulfill users' needs, caused by some of the reasons described below.

- a) Delay in replacing parts of service cars used to inspect the road, causing a high rate of immobilization in the vehicle fleet;
- b) Delay in responding to emergency situations due to an inefficient communication systems used by the involved parties;
- c) Governmental bureaucracy;
- d) Lack of adequate service cars to attend some kinds of emergencies;
- e) Inadequate legislation;
- f) Extinction of maintenance and conservation contracts;
- g) Non-payment of hired service companies, causing a reduction on the teams involved in performing services.
- h) Delay in solving problems related to slope stability when slides occurred;
- i) Inadequate conservation and maintenance of special engineering structures;
- j) Vertical signaling in bad conservation status and with a very low level of retroreflectiveness;
- k) Lack of maintenance and conservation of horizontal markings with no demarcation or low level of retroreflectiveness;
- l) Lack of verification, conservation and maintenance of draining devices;
- m) Inadequate geometry with no special attention with safety elements in some segments;
- n) Lack of road safety elements such as overpasses in urban perimeters and guard-rails;
- o) Reduced effective personnel for inspections;
- p) Non-existence of campaigns related to traffic awareness and well-behavior
- q) Weighing stations with damaged equipment, hindering correct inspections related to excess of weight on the road. This situation resulted in an increase of pavement damage and a higher risk of accidents;
- r) Non-existence of communication between the communities and road-nearby companies. This hindered a plain awareness of the road's importance and its benefits to interested parties;
- s) Lack of maintenance and conservation in total land requirement.

It's worth mentioning that during this period, no toll gates were constructed and all financial resources used in emergency situations were sourced from taxes charged on vehicles and other taxes proceeded from public treasure. These resources were foreseen in the government's annual budget, at federal and state instances.

As soon as it took control of this road, the Concession company started preparing the preparation to attend emergency situation, aiming to seize what was recommended in the PER (REP, Road Exploration Program, the abbreviation in Portuguese). This program presents parameters to allow the solving of exceptional situations that might occur on the road, along with measures to provide a safer pass through the road to its users.

3. EMERGENCIES MANAGEMENT IN THE BEGINNING OF THE CONCESSION PERIOD

After the moment when Road BR-277/PR operations were handed to ECOVIA (January 1998), an emergency management structure was created. These emergency situations started to be reported to the CCO (OCC, Operational Control Center, the abbreviation in Portuguese), which managed the actions taken by the necessary teams for each situation.

Inside the emergencies attending structure, inspection teams were very important elements aiming to detect and provide resources to solve problems found. The traffic inspection structure was composed by three routes; each of those covered the following segments: Route 1 - from km 0 to km 11 of BR-277 plus 50 km of other roads under the concession company's responsibility; Route 2 – from km 11 to km 49 and Route 3 – from km 49 to km 84. In the days with a predicted higher amount of traffic, 2 vehicles were added to inspection team.

Each mechanical aid support team, 5 in the total, were composed by three trucks equipped with small winches, one truck equipped with a medium winch, one truck equipped with a heavy winch and 4 ambulances. All these teams were formed by qualified and trained personnel to attend the kinds of emergencies each one was assigned to.

The attendance control book and its registers were made as a manual and archived at the concession company's office. At that moment, there was no computerized system to manage these situations.

The mechanical and pre-hospital attendance services suffered reorganization in 2000, besides being outsourced to different companies.

In 2001, the SIGO (OMSY, Operational Management System, the abbreviation in Portuguese) was created. This started to be a computerized tool to manage emergency actions alongside BR-277. Along with this, some changes were made in the attendance structure with an optimization on operational team. The main modification was the fusion between traffic and toll teams. Some other changes were, the traffic inspection services have been outsourced and the inclusion of a specific service car to attend accident involving vehicles carrying dangerous loads. It's worth mentioning that this item wasn't foreseen in the concession contract and that nowadays, ECOVIA is the only road concession company in the state of Paraná to make use of a vehicle of this nature.

Always looking for improvements, the concession company changed, in June 2004, the company hired to perform mechanical attendance services including its equipments. It's also necessary to point out that during the state's agricultural harvest period (between March and October) an additional truck equipped with heavy winch is

included in the mechanical attendance team, in order to perform any services that might be needed due to harvest transportation accidents. Throughout the time, ECOVIA's organizational flowchart was modified with the creation of two new departments: User Relationship and Attendance Department (2002), today called Ombudsman, and Road Planning and Safety Department (July 2004).

4. ROAD EMERGENCIES MANAGEMENT AT THE PRESENT TIME

Nowadays, to better manage emergency actions, ECOVIA maintains in the CCO (OCC, Operational Control Center), a headquarter with information and control to set in motion any necessary action mechanism. This Center is under GEAU's (UAMU, User Attendance Management Unit, the abbreviation in Portuguese) responsibility, which, along with five specific departments, handles on the most complex services in a road: Its operation and how to keep it with a regular traffic flow and without accidents throughout the year.

The OCC is located at the Toll Plaza on the road's km 60 and has resources to receive and set in motion any team involved on emergency situations.

The CCO can be required to attend an emergency in the following scenarios:

- a) By a user/interested party using a toll free 1-800 phone number (0800 41 0277);
- b) Inspection vehicle circulating throughout the BR-277's 84 kilometers. The maximum gap between one service car and another, in any point of the road, is of 120 minutes;
- c) Closed-circuit TV with nine mobile cameras and other two fixed ones;
- d) Any concession company employee circulating throughout the road;
- e) Employees of hired companies performing services on the road;
- f) Federal Road Police employees;
- g) Personal attendance one of the three SAU (UAS, User Attendance Services, the abbreviation in Portuguese) headquarters, located at km 10, 35 and 61.

It's worth mentioning that in the Road Exploration Program were foreseen the implementation of call boxes, which should have been installed at each kilometer, alternated between the two tracks. Despite this fact, due to an easiness in accessing mobile telephony and to the existence of some points containing fixed telephony devices throughout the road, the concession company proposed to the Concessor switching these call boxes for a new communication system between the company and the users through toll free call structure. The proposal was accepted and the system was implemented. This new system allows, through telephony communication, to reach the OCC and it adopts the necessary measures to handle each situation. After the OCC has been alerted, it sets in motion the ECOVIA's emergency attendance team and the Federal Road Policemen (in case they didn't started the alert). At the moment they set the teams in motion, they search for a team that can easily and quickly get to the emergency location.

The emergency attendance structure regarding accidents involving vehicles and human beings is composed by three routine teams and a supplemental one, which are

strategically located at the UASs (km10, 35 and 61). Each team is formed by a rescue driver and a nurse aid with basic support ambulance. The structure also has a 24-hour physician located at km 35, next to the half mark of the road and he is provided with a specific purposes vehicle. When the physician's presence is needed at the accident location, the ambulance becomes a mobile ICU since the doctor makes use of advanced support equipments such as a defibrillator and etc. Besides all these equipments, there also available tractor-trucks for trailer tensioning, specific vehicles for animal apprehensions and equipments to attend accident involving dangerous loads.

About team members working with these vehicles, they are high qualified and specially selected employees, trained to perform their tasks and adopt suitable procedures for each situation.

Activities developed during the attendance of an emergency are: correct signaling on the location to avoid other accidents; registering information from the involved parties and from the accident for future analysis and preventive actions; mechanical attendance to restore the original road configuration to also avoid other accidents; and medical attendance to the victims, handling the problem at the accident location and/or transporting the victims to a hospital in necessary.

After this attendance, if it's necessary to remove people involved in the accident to a hospital, they are taken to one the four public/private medical facilities located nearby BR-277/PR.

In accidents with exceptional conditions, where multiple victims are involved or the accident extension is big, Federal orgs (such as the Fire Department) can be set in motion to complement the attendance provided by the concession company teams.

It's worth mentioning that each team has its acting procedures and regulations, according to their attributions, which have been perfected throughout the years based on info collected and inputted on SGR (RMS, Road Management System, the abbreviation in Portuguese). This allowed creating a huge database aiming to for improvements on operations and on attending and solving emergencies.

In cases of accidents involving dangerous loads, there's an specific plan, called PAE (EAP, Emergency Attendance Plan, the abbreviation in Portuguese), which guides in a clear the specific actions for these situations, minimizing or eliminating further damages.

It's also necessary to comment that the RMS implementation on 2003 was critical for managing abnormal situations on the road. This system currently allows following up situations and further an statistician study about it which can lead future actions and can adequate attendance teams regarding positioning and composition, besides defining new actions that should take part annually on Accident Prevention and Reduction Plan.

During periods where an increase on the traffic amount is foreseen (vacation periods, holidays, etc), additional mechanical aid teams are set in motion in order to handle all possible emergencies. The size of these teams is set according to RMS registers, observing how often problems occur and the probable amount of vehicle circulating on the road. This is made based on the history of system registers in similar periods. The management tool (RMS) has allowed guiding actions which result on elimination of potentially dangerous situations throughout the road. After some analysis, the proposed actions are inputted in the PPRA (APRP, Accident Prevention and Reduction Plan, the abbreviation in Portuguese) for them to be applied.

This Plan, after made available at the beginning of each year, is monthly reviewed in order to adequate it and to allow improving attendance and road's quality. Amongst the actions on the plan, it's possible to highlight the following:

- a) Implementation of guard-rails in locations were occurred accidents related to track transposition and/or vehicle escaping from the road's platform;
- b) Implementation of a new pavement with an adequate roughness(Cap Seal and SMA);
- c) Implementation of lighting systems in location with higher rate/possibility of accidents;
- d) Operations with speed control systems, used to guide Federal Road Policemen actions in order to restrain users driving over the road's speed limit;
- e) Relocation of road accesses and bus stops;
- f) Inspection of the Right-of-Way;
- g) Construction of pedestrian overpasses in urban perimeters;
- h) Revitalization and application of metallic guard-rails;
- i) Execution of adequate conservation and maintenance in draining devices and Special Engineering Structure;
- j) Implantation of specific signaling in pre-determinate locations;
- k) Maintenance and reinforcement of vertical signaling and horizontal markings existent in potentially dangerous locations;
- l) Execution of educational campaigns in the nearby communities and in transportation companies that use BR-277;
- m) Implementacion of antiglare screen;
- n) Increase on the road's traffic capacity with the construction of the third traffic lane;
- o) Structural restoration of viaducts and bridges;
- p) Implementation of safer bays;
- q) Bridges and viaducts widening;
- r) Parapets replacement on bridges and viaducts;
- s) Pavement restoration.

It's worth mentioning that, at the moment; there are no statistical studies regarding types of accidents involving vehicles (e.g.: collisions, fallings, etc) due to the fact the Concession company is paying more attention to tracking the number of victims.

For this reason, it's not possible to provide more specific data about vehicle accidents. Also because of this, it's not possible to clearly associate each implemented measure to the reduction of specific types of accidents. This correlation requires a more elaborated study that hasn't been developed yet.

The positive effect caused by the actions above can be proved in the reduction of the numbers of victims as it can be seen in charts and graphs below.

YEAR	1999	2000	2001	2002	2003	2004	2005	2006
Death Resulting Accidents	42	34	45	44	37	32	38	41
Wounded Resulting Accidents	430	447	537	465	537	604	570	479
No Victims Accidents	888	773	808	780	808	895	697	686
Total	1.360	1.254	1.390	1.289	1.382	1.531	1.305	1.206

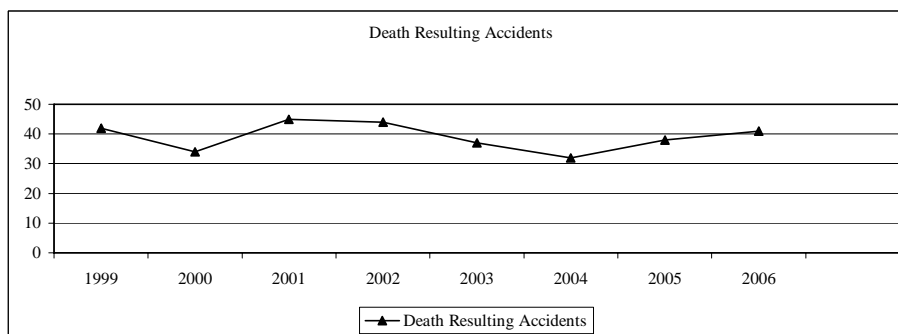
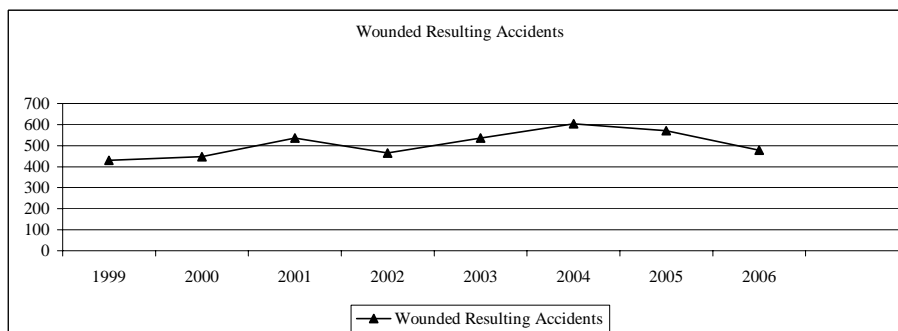
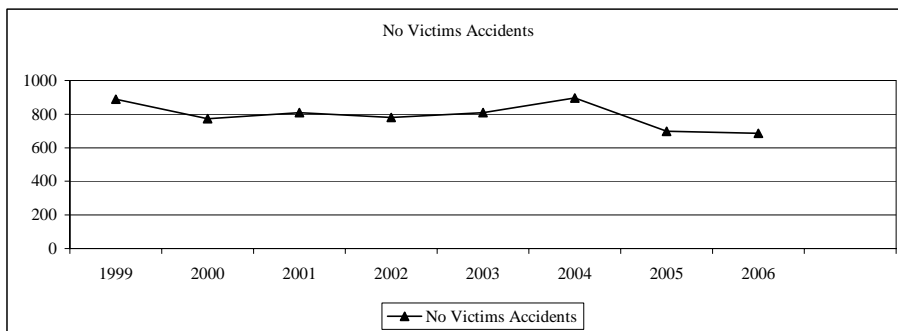


Figure 1 - BR-277/PR's accident and victims number evolution

YEAR	2000	2001	2002	2003	2004	2005	2006
Running Overs	99	85	57	63	65	64	51
Death Resulting Victims	27	27	18	20	19	24	17

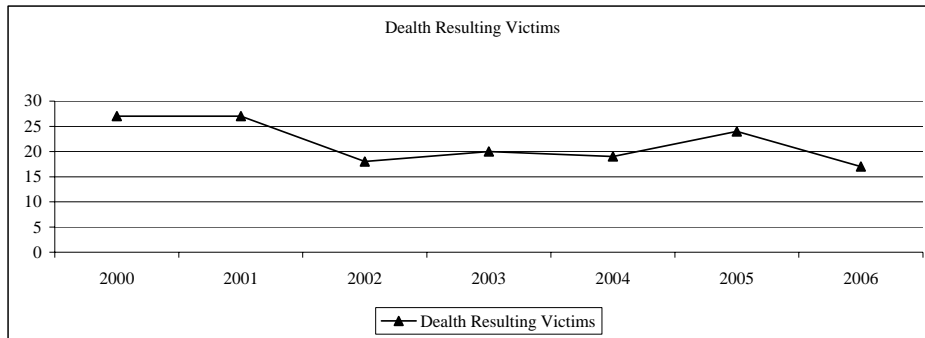
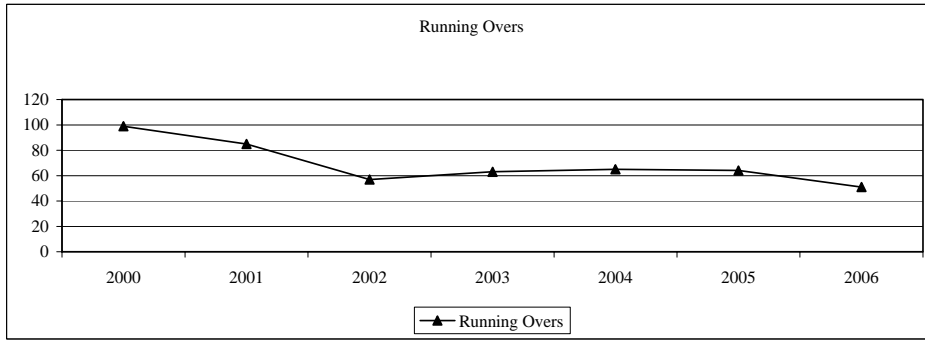


Figure 2 – BR-277/PR’s Road’s Running Overs Table

Service cars involved in attending emergencies are equipped with radiofrequency systems able to reach all road extension and nearby areas.

The organization structure available has the objective to follow what was agreed on the REP, in terms of attendance time. In a comparison look, it’s possible to verify that the current average attendance time is of eight minutes, while the target predicted on the REP is ten minutes.

In case of accidents involving engineering elements (slope sliding, barrier destruction, serious damages on the road pavement, etc.), the attendance team at the accident location performs a brief evaluation and warns the OCC about the damage dimensions. Based on this, conservation and maintenance teams are set in motion to work at that specific location. These teams are composed by engineers, technicians and laborers, equipped with front-end loaders, dump trucks, motor-graders, tank trucks and hand tools.

Whenever necessary, these teams can be added with supplemental resources, depending on the situation’s extension and seriousness. These additional proceedings

are easily executable due to agreements signed between the concession company and other companies located near the road and capable of providing necessary resources in a fast way, for an indeterminate period of time.

It's worth mentioning that, both in accidents involving vehicles and humans and involving engineering elements, the teams belong to outsourced companies hired by the concession company through specific contracts for each service.

In case of accidents/incidents that may involve the environment, teams are ready to perform an immediate intervention in order to avoid and/or minimize any damages.

In situation where dangerous loads are involved, these teams make a preliminary attendance while the responsible parties don't reach the location. This procedure exists due do Brazilian laws in which the load owner companies and the carriers are responsible for solving and avoiding environmental damages.

Also due to current legislation, Paraná's Environmental Institute is warned whenever necessary, to follow up actions taken. Eventually, the Brazilian Institute of Environment and Natural Resources (IBAMA, the abbreviation in Portuguese) is also warned and verifies the extension of possible damages and measures to contain and/or avoid problems sourced from harmful products to the environment.

It's necessary to comment that the concession company is certified under ISO 14000 rules, which shows its concern with environmental issues.

Emergency situations are communicated to the authorities, as well as road users, aiming to fulfill the concession contract and hindering higher risks and long vehicle lines on the road. The communication methods used are fast ways to all interested parties and further reports to the suitable authorities.

Communication with users is made through emergency road signaling, variable messaging panel, warnings at toll plazas and weighing stations, press (radio and TV), updates on ECOVIA's web page and information provided by phone via toll free call, when users are searching for traffic conditions.

To supply emergency conditions, the amount of human resources permanently available is of 60 and 40 people, respectively for pre-hospital and miscellaneous attendances. The number of employees involved in engineering actions is variable and defined according to damage extension.

5. RESULTS

Analyzing info obtained in this technical and some elements provided by the RMS and ECOVIAS employees, it's possible to conclude that:

- a) Actions taken by the concession company tend to reduce the number of accidents, making possible to its users to have a faster, safer and more comfortable trip.
- b) The types of accidents occurred have been changing due to engineering improvements on the road. For example, before the concession period, back and/or lateral collisions often happened due to poor signaling or pavement problems. After the pavement improvements and correct signaling implementation, the main cause for accident proved to be speeding by the drivers;

- c) The fact the road was handed to a concession company since 1998 caused a huge improvement on road users' attendance with the availability of regular information, mechanical and medical services.
- d) The concession company's measures and its services made possible for the public coffers to save around US\$ 80.000.000 since the beginning of this concession period (June 1998) until the end of 2006. This amount was obtained based on the average numbers of studies about social and economical impacts caused by traffic accidents on Brazilian roads.

6. FUTURE ACTIONS AND MEASURES

Aiming to reach better results regarding accidents reduction and road users' attendances, as well as provide more safety for those who live nearby the road, the concession company permanently performs researches that conduct them to reach these goals besides being up to date with Road Exploration Program.

Among the predicted measures are:

- a) Starting on 2007's second semester, the service cars involved on emergency attendances will be monitored by GPS (Global Positioning System), which will allow a cost reduction on this kind of services, rationalization of fleet usage, attendance time reduction and service quality improvement;
- b) Implantation of a weather station to guide users and adoption of measures to avoid accidents caused by bad weather and atmospheric conditions;
- c) Increase of campaigns to keep road-nearby communities aware of its importance;
- d) Maintenance on the road's weighing control, aiming to hinder weight excess on commercial vehicles;
- e) Maintenance and magnifying of dangerous load transportation's inspection;
- f) Improvement on lighting devices and systems;
- g) Immediate engineering actions to minimize and/or eliminate potential risk of accident locations;
- h) Intensification of speeding inspection throughout the road.

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