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FRA/Volpe Center Task Force Observation of Operations at TVE Transrapid Test Facility

October 15 to December 17, 1992

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Background

Maglev technology is currently being considered for several passenger ground transportation corridors in the United States. A franchise has been awarded by the Florida High Speed Rail Commission to Maglev Transit, Inc. (MTI), to build a demonstration project in Florida. A maglev system, linking a station at the Orlando International Airport with a station approximately three miles east of Disney World on International Drive, will be constructed for operation over a 22.5 km route at speeds up to 400 km/h. Currently in the planning stages is maglev service between downtown Pittsburgh, PA and the Pittsburgh Airport. Other routes--such as Baltimore, MD to Washington, DC; Pittsburgh to Cleveland, OH; Pittsburgh to Harrisburg, PA; and the Kennedy Space Center to Port Canaveral, FL--are also being considered.

Under the provisions of the Rail Safety Improvement Act of 1988, the Federal Railroad Administration is responsible for ensuring the safety of any maglev systems implemented in the United States. The FRA and the Volpe Center have been assessing the safety implications of many of the recently developed high-speed guided ground technologies, including the German Transrapid maglev system, under the FRA-sponsored High Speed Guided Ground Transportation Safety Program.

This report describes the operations witnessed and the relevant information obtained by nine members of the FRA/Volpe Center High Speed Guided Ground Transportation Safety Task Force during 9 weeks of observation of maglev developmental certification testing at the TVE Transrapid Test Facility at Emsland, Germany.

These observations are part of an extensive review of the German safety certification process being applied to the Transrapid (TR) system for application in Germany. Although Task Force representatives have visited TVE in the past, this observation effort was the first extended on-site visit (more than 2 or 3 days) at TVE.

The Task Force observation team was hosted by and received information from several members of Industrie-Anlagen-Betriebs-Gesellschaft (IABG) and TÜV Rheinland (TÜV). The primary contacts from IABG included the following individuals:

- Mr. Raasch, the Director of the TVE Test Facility
- Mr. Steinmetz, Deputy Director of the TVE Test Facility for the Operating Control System and Computer Systems
- Mr. Fürst, Deputy Director of the TVE Test Facility for Propulsion System, Guideway, Vehicles
- Dr. Korb, the Guideway Specialist at TVE and Head of the Guideway Development Group

Dr. Schmitz, Head of Noise Testing at TVE
Mr. Decker, Head of Operations at TVE and the day-to-day point of contact for the Task Force observation team

The primary contacts from TÜV included the following individuals:

Mr. Wiedenmann, the Project Manager for Railroad Control and Software Technology and the Task Force's liaison with TÜV and principal point of contact
Mr. Blomerius, Project Manager for TÜV at TVE
Dr. Krebs, Software Analysis and Verification Lead Engineer

TÜV is expected to be reorganized in 1993. As part of the TÜV Rheinland Gruppe, the current TÜV will become TÜV Rheinland Sicherheit Umweitschutz (TSU), and will be a profit-oriented privately held company.

Items of General Interest Noted by the Observers

This section contains general information about the TVE Test Facility and the Transrapid TR07 vehicle. It is presented to provide an overview of some of the technology, operations, and terms that appear in the next section--the daily account of the activities during the observation period. Many specific tests and developments involving the items mentioned in this section will be described and discussed in greater detail in the daily account.

TR07 Vehicle Sections

The TR07 vehicle has two sections. One of the sections is set up for passengers; it has 50 seats. The other contains the instrumentation panels and displays: chart recorders and oscilloscopes next to six 19-inch racks with printer and CRT displays of various train functions. Every device is accompanied by a seat affixed to the floor.

A 27-channel chart recorder keeps permanent history of magnet temperature, outside ambient temperature, inside temperature, operating speed, and other parameters.

CRT displays driven by PCs using DOS version 4.0 keep real-time displays of battery charging levels, train speed (maximum speed during the tests was about 250 km/h), gap distance indication, and magnet current. The CRT display for gap distance shows each individual magnet's gap distance in bar format and uses color to indicate tolerance limits (red, yellow, and green). When the vehicle sets down, the gap between the magnets and the stators is roughly 26 mm.

The primary on-board power is supplied by four separate 440-VDC battery units in each of the two vehicle sections. These batteries also provide power for the levitation system. The batteries are arranged to maintain levitation of the vehicle section if one battery unit fails, although live verification of this feature, apparently, is not done. This battery arrangement also feeds alternate magnet sections to keep the load on the remaining magnets distributed.

The battery charge-level display on the CRT shows real-time status of all of the battery units for the entire vehicle, including voltage and power. Variation in voltage from 360 to 516 VDC was observed for each battery unit. Because the vehicle-borne linear generator does not provide all electrical needs to the vehicle at speeds less than approximately 160 km/h, battery charging does not occur below 160 km/h. Thus, during many visitor and test runs, charging is performed at the Stromschiene, where five rails are built into the guideway. The battery charging operation is accomplished with three-phase 220 VAC, and the contacts for the charging are in the nose of the vehicle behind a movable panel.

Guideway Structure

The Task Force observers were shown drawings that illustrate the construction of each section of the test track, including both steel and concrete segments. The drawing of the Kanalstrasse section showed that it is actually a curve with a 6,000-m radius, although it appears straight on most drawings and maps. Also shown were the foundation pilings, angled to match the angle of the "A" columns. A pile driver is used at an angle to drill these columns. The driver is then withdrawn, reinforcing rods inserted, and concrete poured in. The pressure of the pour in the type of soil at Emsland causes the concrete to form a bulb at the base of the pier, which acts to secure the pile still further. All support work is cast in place, including columns and the cap over both columns, giving them the "A" shape. "H" shape columns are also used.

Most of single-span guideway segments are 25 m long. Some longer segments (both 31 m and 37 m) have also been developed for use over roads, and shorter beams (such as 12.5 m, 18.5 m, 19.5 m lengths) are used for some of the transition segments. Concrete sections over major roads have a stronger structural design, as required by local codes.

The surface of the steel guideway on the southern loop is painted white in some places and is rough to prevent slipping. Other sections, however, are painted gray, are smooth, and are slippery when wet. The sliding surfaces are steel and are smooth.

The guideway structure of the northern loop can accommodate an operating speed of 300 km/h and the southern loop 230 km/h. On the straight section of the guideway, the maximum speed near the only existing substation is 435 km/h. However, as the distance from the substation increases, the speed cannot be maintained because of line losses. By design, propulsion sections are longer where there is no normal need for acceleration, e.g., on the northern loop. Actual speed varies depending on wind speed and centrifugal force, but for ride quality, the vehicle must not exceed 1.5 m/s^2 lateral acceleration according to the German standard for ride quality. (Crosswind speeds of up to 25 m/s are considered to be normal and have no effect on the operating speed of the vehicle.)

Switches

The TVE Test Facility has three switches. Switches 1 and 2 are electromechanical, and Switch 3 is hydraulic. Switches 2 and 3 are designed for high speeds (i.e., up to 400 km/h) in a non-turnout setting. Switch 1 is a low-speed, 70-m-long box beam switch and is used to divert the vehicle into the maintenance facility. Switch 2, on the northern loop, is a 150-

m-long bending box girder beam with a turnout radius of 1,815 m and has three actuators. Switch 3, on the southern loop, is a 150-m-long box beam bending switch with eight active actuators; there is a flat transition curve but no spiral. Although the operational speed limit is only 200 km/h on a diverging route, this switch has a top design speed limit of 280 km/h at a lateral acceleration limit of 3 m/s^2 on the diverging route. The operational non-diversing through speed limit is 400 km/h.

Operation of the hydraulic switch is monitored by various sensors that track the position of each of the eight actuators and the position of the end of the beam. Failure of one actuator, except for the end actuator (i.e., the one with the longest travel), is acceptable as long as the "locked" position is achieved. However, if an actuator fails, vehicle speed must be reduced to maintain the same level of ride quality.

TÜV staff mentioned that the Florida project will probably use a low-speed switch, the same type of box beam construction as Switch 1 and the same type of electromechanical control drive as Switch 2. Electromechanical switch control is preferred for reliability, not for safety. Because heating, or bubbles in the hydraulic fluid, reduces hydraulic pressure, the hydraulic system seems difficult to use; it requires positive pressure to maintain proper locking after it is positioned. TVE has experienced problems with hydraulic switch system operation. For example, the low temperature of hydraulic oil during the first operation in the morning and non-synchronous function of various pistons could cause box beam bending damage when manually recovering from an automatic shut down and incomplete closure into proper alignment, thereby stopping the vehicle. Compounding the problem is poor welding quality assurance attributed to the to thickness (25 mm) of the wall of the piston cylinder. IABG completely rebuilt the hydraulic system and controls for Switch 3 about 3 years ago. However, it is likely that the switch used in Florida will also include the design of the bending beam portion of Switch 3.

Switches 2 and 3 each have a walkway. Each walkway has a stairway at one end and a ladder at the other end, to provide access to the switch and egress from the vehicle. Both of these ways down are protected against unwarranted use: the stair by fencing with a locked door and the ladder by a metal fitting at the bottom. The railing sections along the walkway can be lifted up at any location to permit exit from the doors of the vehicle section. It is necessary to step down from the vehicle section about 2 feet and then up again to reach the platform leading to the stairway.

Guideway-Related Facilities

The "noise wall" is a test simulator, located on the northern loop, for various noise generating structures, activities, and phenomena such as tunnels, side-by-side passage of two vehicles, and gusts and crosswinds.

The Incremental Vehicle Location System (INKREFA) is a series of passive coded tags at 200-m intervals along the guideway. A portion of the INKREFA on the vehicle interrogates these tags to determine the location of the vehicle.

Guideway-Related Issues

Fasteners	The "nutstein" is a channel-shaped piece that slides in a retaining groove of the stator pack. There are two nutsteins per stator pack. They are a critical non-fault-tolerant part of the fastener assembly that holds the stator pack to the guideway using four guideway mounting bolts. Fracture type failures have been discovered in several stator pack/guideway attachment assemblies.
"Vergussmortproblem"	This issue involves premature failure of the special epoxy-bonding or "casting mortar" in the stator pack fastener assembly sleeve in concrete spans.

BLT System

The BLT system is a specific set of hardware and software control items within the TR07 vehicle's Operating Control System (OCS). The BLT II is a 2-channel system that provides safety. BLT III is a 3-channel system that provides both safety and reliability, but no more safety than provided by BLT II.

Testing of the BLT system was the major element of the certification testing at the TVE Test Facility.

Certain aspects of BLT testing began on October 28 with simulations while the TR07 vehicle remained in the maintenance bay. Actual testing with the vehicle in operation began on October 30. BLT II testing, as originated by TÜV, was in its initial stages. It was estimated that BLT testing would require roughly 45 test-days spread over 3 months, making the completion date for TÜV testing of the BLT roughly the end of January or beginning of February 1993. A general test plan had been prepared by TÜV. The detailed testing would depend on the results of the testing of 4c software branches performed by Siemens. TÜV had not received the results of that testing.

Some items of interest planned for observation during the 9 weeks included the following:

1. Test plan and certification testing of BLT II under full automatic operation
2. Certification testing of new magnets (The new magnets were not ready.)
3. On-line gap measuring and dropped stator pack detection system tests
4. Testing of "safe hover" and "programmed braking"
5. Long-term testing of the switch to be used in the Florida application

6. New stator attachment

7. Guideway forces, endurance testing, noise testing, continuous operation

Emergency Braking Conditions

Class I - The vehicle stops via the eddy current brake and sets down on the skids when the speed reduces to roughly 100 km/h, rendering the eddy current brake inoperative. The possibility of reducing the skid set-down speed to 10 km/h for an application system is being studied. The proposed method involves eddy current brake operation with a mix of frictional braking via contact of certain elements of the eddy current brake. This would reduce the present skid braking margin of error, with the set down speed of 100 km/h, of roughly 700 m to about 100 m.

Class II - The vehicle stops via the regular service brakes (the propulsion system) through deceleration via traction power and dynamic propulsion current reversal, and maintains levitation.

TVE- and BLT-related terminology

Halle (Versuchshalle)	The main hall building in the TVE Test Center where the TR07 vehicle is normally stationed for storage or static testing (The section of guideway inside the Halle is equipped with standard linear motor long stator windings to allow the vehicle to travel to the main guideway.)
HHP	Hilfes Halte Punkt (Help Halt Point) The safe stopping point for safe hover (It is normally followed by a number, i.e., HHP 24.)
HHP AUS	Safe hover or safe stopping point feature is disabled. (If an emergency stop is elicited under this condition, the vehicle will stop at maximum deceleration and will not attempt to reach a safe stopping point.)
HHP EIN	Safe stopping point feature is enabled. (Under this condition, the vehicle attempts to achieve a safe stopping point.)
Stromschiene	The charging station, which is built into the guideway in a section adjacent to the passenger loading station, where the TR07 vehicle's 440-VDC battery system is charged after set down
Antriebsabschnitt	A long stator section normally followed by the number of the section, i.e., Antriebsabschnitt 38

Gesperrten Abschnitt	A blocked long stator section
Betrieblicher Bremse	The service brake, i.e., the dynamic brake used during normal operation (Propulsion power must be present to allow use of the service brake.)
Leitstandpult	Operator's console and display in the TR07 vehicle

Periodic Meetings

Mr. Prolifka of Testing and Planning Company for Maglev Systems (MVP) and Mr. Miller of Thyssen Henschel chair a coordination meeting held between the various parties at the Test Facility every 5 to 6 weeks. Mr. Blomerius of TÜV is a regular participant in these meetings.

Visitor Arrangements

The Test Facility regularly conducts visitor runs on the TR07 vehicle for invited guests and the general public. There are several categories of visitors, ranging from I (ministry level) to V (local farmers, etc.) Local tourist groups can make arrangements with IABG to visit Emsland and ride the TR07 vehicle. The rides are free, and the visitors arrive by the bus load. Data are collected on the system during each visitor run, and are analyzed later. Additionally, there is an observation center at Dörpen (a town adjacent to the Test Facility). It is open during the summer until November 1. Visitors are shown videotapes, and when the northern loop is operational, the train can be seen as it passes by. Mr. Rummelait of the city "Chamber of Commerce" said that the center opened in 1986 and had 175,000 visitors last year.

Daily TVE Test Observations

Thursday October 15

Several weeks of operational testing with the TR07 vehicle had recently been completed. On this day, however, the TR07 vehicle was in the maintenance/test bay in the Halle. The side panels of the vehicle sections had been removed, revealing both the lateral guidance magnets and eddy current brakes.

Representatives from Siemens conducted simulation tests of the OCS software between October 15 and 20, making the TR07 vehicle unavailable for guideway tests during that period. The purpose of these tests was to verify elements of the program that were changed in response to TÜV comments earlier in 1992. These were industry tests and were not part of the TÜV certification process, but TÜV did send three observers, including Dr. Krebs, for this day's testing. The simulation included using as much of the operational system as possible without moving the vehicle. In addition, certain signals were injected to simulate actions, e.g., the opening of a switch after the train had passed the last safe point, that would never be allowed during test runs. These specific simulations were described as branch testing. Specific elements of the software were exercised. Testing all possible paths of the software was considered impossible. Branch testing was considered to be the best alternative, as testing all of the branches would, it was believed, prevent unforeseen actions from occurring, regardless of the ultimate path through the program. Need for both black box and white box testing was noted by Mr. Wiedenmann. Black box testing is output oriented, and white box testing measures actual internal performance of the program. TÜV was given access to the results of these 4 days of tests.

Mr. Decker described the planned implementation of an on-line stator pack monitoring system; the TR07 vehicle still operates with an off-line system. There was a desire to develop a monitoring system that would compare loaded versus unloaded stator pack position. The whole issue of the stator pack bolts was discussed at length. The plan was for all new bolts to be characterized via ultrasonics before installation. Then a sample (approximately 10 percent) would be tested ultrasonically when in place and properly torqued, and tested again later. Deviation in length would be used as an indicator of loss of torque.

Another issue related to the bolts is the status of the bolts on the steel section of the northern loop. The bogies on the TR07 vehicle have been modified so that contact between a stator pack and a vehicle section will no longer be a safety issue, thereby limiting damage to the section. To address the bolt fatigue problem, Thyssen Henschel wanted to use this portion of the guideway to test some of the possible modifications to the bolts and/or fixture. However, the guideway in question is on private land, and TÜV, which is responsible for ensuring the safety of the public, has concerns about such testing. One of the issues under discussion between Thyssen and TÜV is the statistical risk for such test operations and the implications of the risk.

Mr. Decker also mentioned that the control console on the TR07 vehicle has had electromagnetic interference (EMF) problems. It was not clear whether both consoles were affected or just one. The interference does not affect the safety control computers and is only an issue for the operator on board the vehicle when the vehicle is controlled by the operator and not by Central Control. Apparently, a clear method for resolving these problems has not been established. Some form of hardening and/or use of military specifications was being considered, but the cause of the problem was not yet known.

During a discussion of the length of guideway beams to be used for the Florida application, both Mr. Wiedenmann and Mr. Decker expressed surprise that a 25-m span would be considered given some of the deflection issues that are known. Mr. Decker mentioned that on some mornings in the fall speed restrictions are required because of a reverse camber in the beam, as the ground (and thus the underside of the beam) is warmer than the upper air (and the top of the beam).

Dr. Schmitz shared all of his noise data from the recent tests, explained in some detail how the array system being used helps to find noise sources, and conducted a tour of the IABG test van. The system has microphones that appear to be irregularly spaced, but in fact the system contains three sets of 13-microphone arrays for analysis of three different frequencies for any one run. The spacing can be changed between runs. The arrays can be elevated up to 15 m, enabling a height of 5 m above the TR07 vehicle on guideway sections that are elevated 7 m (the vehicle is 3 m high). The array system feeds a 28-channel analog tape recorder, and the data are digitized and recorded at the same time. Two channels are used to record the output of photoelectric cells and to sense the position of the vehicle, giving a precise location relative to the other data and a precise measurement of the speed as the vehicle passes the arrays. In addition to numerous computers for data reduction and analysis, the van contains a four-track analog recorder for measuring the traditional dB(A) levels from a single microphone.

The displays on the TR07 instrumentation vehicle section were observed. Data collected and displayed include the battery voltages, temperatures, amperage, and amperage demands.

In the test area of the Halle, one of the gap control electronic trays heavily sensored with temperature strips of 170° F (77° C) to 240° F (116° C) was observed; none of the strips appeared to have even reached 170° F (77° C). Against one wall was a TR06 levitation magnet package. It was attached to a power supply for what appeared to be extensive overheat condition testing. The insulation indicated some significant cracking that seemed to be thermally related.

Friday October 16

The Task Force observer met with members of the group developing the ultrasonic length measuring system for maintenance monitoring of bolt tightness. A member of the group made a detailed presentation on the operation of this system. As part of other research tests, a stator pack was changed on the double-span concrete beam, and the ultrasonic measuring system was used to check the torque of the bolts on the re-installed stator pack. An electronic torque wrench system, another method for checking bolt torque, was also demonstrated.

Several of the technicians involved in the ultrasonic testing study noted that they hoped that, if this system was adopted, all new bolts installed would be manufactured to meet a specific length within pre-determined error limits, thereby eliminating the need to characterize every new bolt.

Monday October 19

The Siemens simulations continued and were observed from both the TR07 vehicle and Central Control. The simulations included response of the vehicle to loss of radio control from Central Control. All of the displays on the control panel responded as if the vehicle were in operation. These included speed limits, actual (simulated) speed, percentage of propulsion (negative or positive) available, and percentage of actual propulsion (simulated) used--all of which were being monitored.

The Task Force observers traveled around and inspected the guideway. Steel and concrete sections of all lengths (25 m, 31 m, and 37 m) were observed. The longer concrete sections were deeper; the 37-m section was almost twice as deep as the 25-m section. Both types of switches, hydraulic and electromechanical, were examined, and clicking of the relay equipment was heard as some preliminary simulation work was performed. The test section of the double-span steel guideway that may be used in Florida was also examined; it uses a flat plate on the bottom, instead of a tube, to reduce cost. Bar codes, used to identify the stator packs, were visible on this test beam.

Tuesday October 20

Various testing and monitoring methods were discussed with Mr. Raasch and Mr. Decker, including the on-line stator pack monitoring system under development that compares loaded and unloaded stator pack position. The stator pack bolt inspection process was also reviewed. All stator pack bolts are characterized ultrasonically before installation. Then a sample (approximately 10 percent) of the bolts are tested in place when properly torqued and tested again at a certain interval. Deviation in length is used as an indication of loss of torque. Another bolt issue discussed was the condition of the bolts on the steel section of the northern loop. The bogies on the TR07 vehicle have been modified to prevent contact between the stator packs and the vehicle in this area. This item is discussed in more detail later in this day's log.

The suspension system of the TR07 vehicle was observed when it was exposed for some modifications. Minor repairs to the shell of the roof were performed. The damage occurred earlier in the summer. While the vehicle was traveling at low speed or was stopped, a crane hook struck the roof.

The Task Force observers toured the switching area (transfer table), where various types of maintenance equipment and the TR06 are stored, as well as the resistor banks and other centralized propulsion equipment. Some portions of the guideway in the storage area had the stator coils removed, and others had the entire pack removed so that the mounting bolts could be seen clearly. The bolts were mounted in the concrete with a steel pad and rubber gasket (about 2.5 inches square).

The "nutstein" was discussed with a TÜV representative. It is a diamond-shaped assembly that holds the stator pack to the guideway. First, the nutstein is attached to a transverse member (the transverse) with two bolts. Then, the transverse is attached to the guideway with two more bolts. Thus, there is a total of four bolts per stator pack. This assembly was manufactured in the concrete guideway with the receiving steel pieces mounted before the concrete was poured.

Next, the eddy current brake configuration was explained. Each vehicle section has two eddy current brakes, one in the center of each side in place of a frame of guidance magnets. The eddy current brake has a two-ridge profile, whereas the guidance magnets have a smooth one-piece cover.

A modification to the leading levitation magnet sections has been planned to prevent them from striking stators that have dropped and possibly being damaged. A deflection device is to be installed ahead of the lead magnet at the front of the vehicle section to lift a dropped stator pack. Additionally, the leading edge of the magnets in the bow will be sloped to prevent a dropped stator pack from catching the edge of the magnet and to allow a dropped stator pack to pass over the magnet even if there is contact.

The northern loop of TVE contains a 5,000-m section of steel double-span 50-m continuous beams as part of the original installation. Two newer 50-m spans have been installed on the Kanalstrasse section before Switch 2 to accommodate readiness for application testing of 50-m beams and new stator pack fastening systems for both steel and concrete. Although only steel beams will be used in Florida, the German government requires testing on both steel and concrete beams. One double-span steel section was fabricated off-site and welded together at the nearby Dywidag facility, where the functional elements (primarily the stator packs) were attached. A double-span concrete guideway section was cast as two 25-m sections and attached via post-tensioning rods, and the gap was filled with concrete. A 25-m steel span can be made to achieve similar operational results as the 50-m span, but it will have a deeper (and less attractive) section, which will require more steel, making the beam more expensive.

Concern was expressed about the condition of the stator pack fastening bolts in the northern loop. Because of the design, portions of the bolts were under no tension despite being properly installed, causing uneven loading on the bolts. Thus, the performance life of these bolts could be lower than that of bolts in other areas of the guideway, and it is unknown how long they will last. Additionally, each pass of the TR07 vehicle results in 150 loading cycles on each load-bearing bolt (one per magnetic pole), not the single cycle as originally thought, thereby potentially shortening the performance life still further.

Certain cool weather conditions produce a negative or reduced camber on the southern loop. As a result, the maximum speed limit is reduced to about 170 km/h, which is not optimum for ride quality. A suspension modification was being tested that would address this factor. Part of the cause of this problem is that some of the beams on the southern loop were installed at the lower end of the acceptable installation camber limit.

The camber of different guideway beams was also discussed. The camber of a simply supported 25-m span was compared with that of the double-span continuous beam. The double-span beam has one-third the deflection in camber under thermal loading, a significant issue in Florida.

<u>Wednesday October 21</u>

With the Siemens simulations completed, the Task Force observers were able to board the TR07 vehicle for a test run. One test run was conducted before tourists were brought aboard. It was conducted from the passenger station to approximately the middle of the northern loop (west side) at a maximum speed of 302 km/h. Some of the instrumentation monitoring displays were observed in the operator cab of the passenger vehicle section. The batteries showed discharge up to approximately 100 km/h. At this point, the eight separate batteries switch over one by one to charge, as the linear generator becomes fully operational to charge the batteries and provide the necessary on-board energy at approximately 160 km/h.

The observers then moved from the passenger section to the research section for the first visitor run (Besucherliste). They noticed little difference, if any, in ride quality between the first run with the passenger section empty and the visitor run with the passenger section full. In the research section, they watched from three seats normally used to monitor the voltage, batteries, and gap and lateral guidance magnets. None of the strip chart recorders were on, but the computers were operating, and monitored parameters could be seen in real time. The observers could see how the batteries first discharged at the lower speeds as the TR07 vehicle accelerated and then went through a neutral to a charging status at about 100 to 120 km/h. A total of six runs were conducted.

One of the visitors runs, with a maximum speed of 302 km/h, was observed from Central Control. The speed control at the operator console was set for 302 km/h, but the allowed speed shown on the display was between 350 and 400 km/h. On the return trip to the passenger station, the Central Control operator dialed in a speed restriction of 170 km/h, which was displayed as a green line on the display under the maximum red line speed. When the vehicle returned, a technician removed a gap sensor, which is installed for test purposes only, and some on-line stator position monitoring sensors. Additionally, two battery containers were removed and replaced on one side of one of the vehicle sections. Battery replacement requires three people, one on each side of the battery to remove it from the vehicle section and to place it on a carrying structure held in place by a fork lift operated by a third person. The process is reversed to install a new battery set. These battery exchanges appeared to be standard maintenance actions. The removed batteries appeared to need new air filters on their front cover. One of the workers said that no battery had failed in the past 2 years.

Thursday October 22

Three visitor runs were conducted, and work continued on the southern loop. New test equipment had been moved into the passenger vehicle section, but none of it had been hooked up. The trip to the loading platform, at about 41 km/h, seemed smoother than the previous day. When the TR07 vehicle reached 130 km/h, raindrops moved horizontally across the windshield. Some bumping was noticed until a speed of 230 km/h was reached. The ride then became progressively smoother as the vehicle approached and exceeded 300 km/h. The speed of the return trip was 172 km/h; a steady lateral rocking motion was experienced.

Following the rides, some sections of the steel guideway proposed for Florida were shown. An inner gusset plate stiffener has been added every few meters inside the triangle shape, but it is not a solid gusset. A major problem with the steel guideway is noise, which is quite noticeable when the vehicle travels over the steel switch or the test section. One possible solution being considered is to fill the lower third of the guideway section with a steel mesh and small steel balls, to vibrate as the vehicle passes and absorb the energy, thereby reducing noise. However, this will add weight, which must be accommodated in the strength of the beams and support structure. Costs were not mentioned. Also shown were drawings of the double-span steel continuous beam for Florida with a glide plate at the middle support to minimize longitudinal stresses in the beam.

Actual design drawings of the concrete guideway (dated May 1989) were also examined. These show the special high-strength steel post-tensioning rods and the plates (eight pairs total) used to hold the rods. The problem with this design is corrosion of the tensioning bars and bolts. Although the bars and bolts are covered to protect them, the protection failed in an earlier construction, and the bolts and rods corroded. There is also no obvious way to inspect the bolts. This type of construction would be very susceptible to corrosion in Florida, and has not been proposed.

Monday October 26

Testing of the OCS (BLT II) functions was scheduled to begin the week of October 26.

Battery maintenance was observed while each cell was being tested. The technicians explained the need to perform a deep discharge on all battery cells before recharging. These are nickel-cadmium aircraft battery cells, some of which have lasted 4 years. Each cell costs DM 200 (approximately $130), and each battery costs DM 700,000 (approximately $455,000). The cells are arranged in eight sections. However, some cells had been removed and replaced with wood inserts. A wire lead ending in a fitting came from each piece of wood. This was a temperature sensor installed for test purposes only; it will not be in the final battery. The temperature of the battery in operation is used as a measure of its working efficiency.

Following the day's visitor runs, the TR07 vehicle was hooked up to the umbilical cord, levitated, and adjustments were made in the suspension and guidance magnets. These adjustments are based on ride quality data collected during each visitor run.

Tuesday October 27

Again, it was explained that the eddy current brakes would be modified for revenue applications. The existing brakes reduce the speed of the TR07 vehicle to 110 km/h, and the subsequent set down is achieved either at or before the designated stopping point by up to 700 m. The goal of the modification is to allow the eddy current brakes to slow the vehicle to 10 km/h and reach, but not pass, the designated stopping place within a tolerance of 130 m.

There is not much difference in stopping distance between wet and dry guideway conditions when the vehicle touches down on the skids. There was no experience base for winter operating conditions, since the TR07 vehicle had never been ready to run during the infrequent periods of snow in the Emsland region.

The bolt torque testing machinery was on the southern loop. The crew was measuring the torque on each bolt holding the stator packs. It is a time-consuming job. Both sides of the guideway are tested at the same time, with four men working on each side.

Wednesday October 28

Static tests using the TR07 computers and Central Control with a guideway functions simulator were held on October 28 and 29. The TR07 vehicle was levitated in a stationary position in the Halle. The static tests simulated the BLT vehicle-borne computers: the fahrsteuerung (FST), or guidance computer, and the fahrsicherung (FSI), or safety computer. A third computer, the FUE, or radio-link computer, was not involved in the static test. The purpose of the static test was to simulate failure of one or two channels within a computer and to verify behavior of the voting system to allow an unaffected computer to take over the operation. When a channel from either the FSI or the FST fails, the operation continues as long as the two good channels of the failed computer continue to agree. When another channel fails, the second computer takes over and performs a safe hover stop. Not much detail on the testing itself was revealed, but some of the testing may have involved probing into the cause of a common-mode failure that was experienced two weeks earlier, when a range violation of variables caused all of the vehicle-borne computers to shut down. There are certain hardware and software control issues that are not very clear. One issue is what happens when the computer shuts down as it did in response to the common-mode failure, and another is the protocol for application of the eddy current brake and Class 1 emergency stop.

The Task Force observers witnessed a simulated run at the main control console at Central Control. The path taken by the simulated TR07 vehicle, speed profile, acceleration, and maximum allowable speed were shown.

A tour of the Central Control area was conducted while a simulation was in progress. The observers watched the panel indications, including the power consumption curve and the maximum and actual speed profile for the simulation. The observers were also able to see how the vehicle was decelerating. The tour then continued through the rooms next to Central Control. The various system controls and both the BLT I and BLT II systems and the machine that switches them in and out were observed. The BLT II uses some of the units of the BLT I, but is still fairly compact.

The TR07 vehicle was being prepared for the arrival of important visitors on Monday November 2--the Minister of Research and Technology (BMFT) and the Prime Ministers of the two states that the Hamburg-Berlin line will pass through. The Task Force observers visited the maintenance bay and examined the vehicle. It was being washed and having new decals (BMFT) affixed. The observers examined the underside of the TR07 vehicle and the TR06 double section 440-VDC battery, which weighs 2,000 kg. Several panels were open on the belly and sides of the vehicle (for the simulation testing), exposing the levitation and guidance magnets and some of the control circuits. The observers looked at the INKREFA sensor assembly, at the head end of the vehicle, and went into the instrumented vehicle section and looked at the instrumentation. Next, the observers examined the research vehicle section and then the passenger vehicle section. They looked at the passenger compartment and the operator console. Just behind the operator cab in the passenger vehicle section are the VIP seats: two very plush seats with a television and telephone. Three inch-round pressure sensors are mounted to the windshield in various locations.

Some of the guideway installations were observed, including the three switches. The observers climbed up on the walkway for a close look at Switch 3, the hydraulic switch. They also saw the reflective material which has been added over the older (darker) concrete to increase reflectivity to reduce the undesired increase in beam camber on hot days.

A technician opened the control house for Switch 3, and the main control box was observed. The switch computer in use at TVE will be replaced by a newer version to correspond to the BLT II equipment. The Task Force observers were told that the new computer may not necessarily be from Siemens, as SEL Company was also bidding to provide a switch computer. Each switch, consisting of seven individual actuators along the movable beam, has its own processing unit. The processing units are housed inside a closed well located next to the switch control house. Except for the last unit at the point of switch, a switch driving unit can fail without making the switch unsafe for travel.

A work crew was checking the stator pack fastenings on the northern loop. The Task Force observers climbed a ladder and stood on a maintenance cart to look at the nutstein and the stator pack fastening system. The northern loop was closed at the transition from concrete to steel beams because of the stator pack fastener failures. With the new redundant fasteners, a second screw is used (with no pre-tensioning) to retain the stator pack position if a primary fastener breaks. Fatigue models of the system estimated that approximately 100 runs with three screws could be made before a second screw would break and allow the stator pack to drop 1 to 2 mm. The system would then rely on the on-line gap sensor to find the dropped pack. Redesigned magnet housing, as discussed previously, has been installed on the TR07 vehicle with a bevel to help reduce damage to a vehicle section if a stator pack does drop. The lead magnets have been faired in so that they are protected from impact with a dropped stator pack.

Next, the observers visited the dual-track simulation wall. Pressure data have been collected and used in numerical models that measure reflections off the wall to approximate conditions of a vehicle entering a tunnel or two vehicles passing, both inside and outside a tunnel. Because the wall protects the vehicle from crosswinds, the wall can also be used to examine the effect of wind gusts when crosswinds are present and coming from the far side of (behind) the wall.

TÜV representatives performed a code walk-through, and repeated a series of simulation tests performed by Siemens earlier to verify the Siemens results.

Problems that have been experienced with the guideway were described by an IABG representative. It seems that, because the guideway is 10 years old and is part of a test facility, some of the early designs have proved to be inappropriate for revenue application. The guideway is basically under designed for the operational cycles that are now planned. Its resonant frequencies are not sufficiently dampened vis-a-vis the TR07 vehicle and propulsion frequencies, resulting in vibrations. When the guideway was designed and built, not all the considerations concerning resonant frequency damping and cycles of operation were taken into account under dynamic load. The cycles of operation were calculated for magnet units, whereas they should have been calculated for single grooves. The resulting vibrations were probably the major cause of the fatigue failures of stator pack bolts that have occurred. The attachment technique of the stator packs is also inappropriate. The bolts used to hold the stator packs are arranged vertically, with loading in tension, and the design is not able to resist the 150 load cycles that occur every time the TR07 vehicle passes. A better design may be to have the bolts in shear, but that is not possible with the existing guideway because of the vehicle's clearance envelope, not to mention the cost of retrofitting the guideway with such a radical change.

Thursday October 29

A static test was conducted by Mr. Wöbeking of Siemens following the detailed test steps designed by Mr. Neumann of TÜV. Dr. Krebs and Mr. Jubin of TÜV also observed the test. The basic purpose was to simulate failure of one or two channels within a computer to verify that the voting system will allow an unaffected computer to take over the operation. Door protection was also simulated. The observers again visited the TR07 vehicle and Central Control, learning about the simulations and about the "real" tests scheduled for the next day. The observers were given a written description (in German) of the simulator system employed for the static tests.

The observers also saw the TR06 battery taken apart and the TR07 batteries being charged. Mr. Wiedenmann discussed the synchronous motor and the importance of its control for limiting loading on the guideway. Without the control, harmonious loads could build up and overload the guideway structure.

The effect of loss of power on one side of a section of guideway and the response of the on-board safety systems were explained. Loss of power on the guideway was also discussed. Most of the work done on this project was on the TR06 vehicle. The TR07 vehicle contains some modifications (such as the INKREFA position-finding system, instead of the guideway-imbedded SICARID pods used on the TR06).

Friday October 30

A dynamic test of the TR07 vehicle in motion was conducted. The test plan was developed per agreement between Siemens and TÜV on October 27. It was agreed that no testing would be conducted that would risk damage to the skids, as they would be needed for a demonstration on Monday November 2 for dignitaries from the Economics Ministry of the State of Schleswig-Holstein, through which the maglev route from Hamburg to Berlin will pass. Thus, the eddy current brakes were not to be used, and emergency stops requiring the vehicle to touch down on the skids were to be avoided. Only in the last test (#10) was the vehicle to set down on the skids after coasting at very low speed. Interestingly enough, this was the only test that did not give the expected results, as the vehicle did not set down on the skids for braking initially, and had to be forced down on the skids. There is a control panel that allows the train to be set down on the skids; it is separate from the main operator's console, where an IABG technician is stationed.

Mr. Wöbeking of Siemens ran the test with Mr. Neumann, the TÜV software engineer who developed the test. Mr. Wiedenmann and Mr. Jubin of TÜV also participated in the test monitoring, on board the TR07 vehicle. Three technicians from IABG: two on-board operators and one operator for manual levitation control served as operating personnel. The Task Force observers witnessed the test from inside a vehicle section. A Siemens engineer and IABG technicians were at BLZ/BLD (Central/Decentral Control). A crew with ladders was in the field to cover and uncover the INKREFA tags with aluminum foil for two of the tests. IABG personnel were at the battery charging station.

Some items of interest were noted during this test. Magnet pole temperature was observed as high as 61° C (outside ambient temperature 7.5° C). The power increased to a high of 45 kW for each battery unit during the acceleration phase, settled at about 15 kW per unit at constant maximum speed, and increased again during deceleration. Battery charging took about 10 minutes each time the vehicle stopped at the charging station. While the vehicle was moving, battery charging mode (einladen) was observed at a speed of about 100 km/h. Magnet current increases to maintain levitation as the gap narrows, and the current returns to zero as the vehicle sets down. The normal gap maintained between the magnets and the guideway is approximately 13 mm until the vehicle reaches 45 km/h. The gap then decreases to 9 mm. To conserve power, the gap maintained for all test and visitor runs was only 9 mm at all speeds. When a gap between guideway sections is reached during operation at this reduced gap between magnets and guideway, one guideway sensor on one magnet interprets the gap as being infinite. The adjacent magnet tries to compensate by reducing the gap, which becomes too small, shutting off that magnet section. This shutting off of the magnets causes bumpiness and/or a thump at slow speeds. Modification of the secondary suspension is being considered to improve the ride quality.

Before testing began, transfer of the Wartungsfahrzeug I maintenance vehicle (see discussion under November 3 for description) was observed from the main track out of the Halle onto a storage track parallel to the Halle exit track. Transfer of vehicles to the parking tracks is accomplished by parallel displacement of a 100-m section of movable track, which is part of the main track leading out of the Halle to Switch 1. It takes about half a minute to deploy the movable track in order to provide access onto the storage track.

For tests 1, 2, and 3, the HHP was disabled (HHP AUS). That is, the vehicle did not try to achieve the safe stopping point. The converse of the HHP AUS is HHP EIN, which enables the safe stopping feature. (See BLT Terminology.)

Because this day was apparently the only day for dynamic vehicle testing and most of the action would be occurring on board the vehicle, both task force observers remained on board, although it was suggested that during operational testing one member remain in Central Control while the other is on board.

A total of ten tests were performed:

TEST 1:

The purpose of the first test was to automatically stop the vehicle via the service brakes before reaching a simulated "blocked section" of guideway. The train traveled north out of the Halle with maximum allowable speed toward a section that had been blocked by the BLZ (the Central Control portion of the BLT system). The test was successful, as automatic stop was achieved with the service brake before the blocked section, and levitation was maintained. Also during this test, the INKREFA groove counts were compared with the count made by an independent checking system operated by Mr. Wöbeking. This is apparently a standard test that is performed regularly to verify proper operation of the INKREFA system. The vehicle returned to charging station (Stromschiene) following the test.

Information is received from the wayside, including the next HHP to look for, the next INKREFA tag to expect, and the number of stator pack grooves to count before the next INKREFA tag. The propulsion system gets the same information.

TEST 2:

The purpose of this test, which was not indicated on the original test plan, was to verify the vehicle's ability to operate in reverse (from the on-board operator's point of view). Reverse operation is needed in yard operations and emergency situations.

During Part A of the test, the operator was at the south end of the vehicle, and drove north a short distance. To execute reverse operation, Central Control must release control of the vehicle to the on-board operator. The operator must use the joystick at the console and hold down the white button on top of the joystick while pulling the stick to the rear. This test was successful only to a point, as the vehicle dropped unintentionally onto the skids because of operator error. Apparently, the operator failed to hold the button down for the full period desired. He prematurely released the button, and the system detected reverse movement (for a distance greater than allowed while standing levitated at a station) and triggered an emergency stop, dropping the vehicle to the skids (very roughly). Except for the operator error, this test was successful.

TÜV personnel mentioned that there may also have been a computer error involved with Part A of the test. A similar error had occurred approximately 2 weeks earlier during a visitor ride. As previously discussed (under October 28), a common-mode failure of both vital 3-channel computers was experienced, and the fault was apparently a violation in the range of variables.

During Part B, the test was repeated in the opposite direction, back to the charging station, with the operator at the north end of the vehicle. This test was successful.

Siemens always maintains a control display of several variables, such as battery charging status, speed, gap distance, and magnet current. There are also several indicators (on Siemens' display) that appear only when the vehicle is running in manual mode: VEHICLE READY, VEHICLE LEVITATING, and VEHICLE LEVITATED.

The ride was very bumpy during Test 2, and there was a loud thump caused by the lower-than-normal gap between the magnets and the guideway at low speeds during the testing.

TEST 3:

This test was performed in reverse operation, using the joystick, traveling north toward a simulated "blocked section." The purpose was to automatically stop the vehicle in reverse operation in front of the blocked section using the service brake while maintaining levitation. The test was successful, as the BLT system stopped the reversing vehicle at the last HHP (safe stopping place) before the blocked section and levitation was maintained. The vehicle returned to the charging station following the test.

TEST 4:

The purpose was to enable the safe stopping point feature (HHP EIN) and to test the safe hover capability. The vehicle traveled north from the station at maximum thrust with HHP strategy on. When the operator display showed HHP 24 as the next safe stopping point, the on-board operator would turn off the console, thereby calling for a Class 2 emergency stop at the HHP. The desired result was that the vehicle would stop automatically, as programmed, via the service brakes (no eddy currents or skids) at the simulated safe stopping point (HHP 24). The vehicle would then return to the charging station.

There was an operator error during this test; the operator turned off the display unit without removing the key, thereby resetting the vehicle and removing the blocked section. Without the block condition, no automatic stop was necessary. The test was repeated successfully, as the vehicle stopped just before HHP 24.

TEST 5:

This test was the same as Test 4, except the safe stopping point (safe hover) feature (HHP AUS) was turned off. Class II emergency operation (i.e., application of regular brakes from speed to full stop at the next safe stopping place) was triggered by turning off the operator console. The purpose was to demonstrate that the vehicle would stop sooner than in Test 4, since it had entered a Class II emergency situation. The desired result was that the vehicle would stop automatically (following braking profile), at maximum deceleration with the service brake maintaining levitation, before HHP 24 (Pillar 386), and would then return to the charging station.

This test initially failed, in the same way that Test 4 failed initially. The operator turned off the console by pressing the reset button it. Initially, the vehicle began to decelerate in response to the loss of operator console, but then the console came back on-line. The system realized that the emergency was over and began to accelerate back to speed.

The test was repeated by turning the operator console off with the key (instead of pressing the reset button), thereby preventing the console from coming back on-line. The repeated test was successful, as the vehicle stopped at Pillar 200 instead of Pillar 386, as in Test 4.

Test 5 was originally planned to be a continuation of Test 4. The stop was to be triggered by the Central Control operator requesting an emergency stop of the vehicle. However, the test was modified after the previous day's simulations, which revealed that such an action would induce a full emergency stop via the eddy current brakes and drop the vehicle to the skids (a Class I emergency). Since this was undesirable, an alternate trigger was used: the on-board operator removed the console key to induce a Class II emergency.

TEST 6:

This test was designed to verify that all manual inputs from the operator console are rejected when the BLT II system is in AUTOMATIC mode. This was a static test conducted while the vehicle was stopped at the charging station. With the system in AUTOMATIC mode, the on-board operator tried various maneuvers: open the doors of the vehicle sections, levitate the vehicle, and make it move forward (i.e., drive). This test was successful, as the BLT II system ignored all of the manual commands.

TEST 7:

The goal was to verify that the BLT II system will automatically interrupt and stop the vehicle at the first designated safe stopping place (HHP) if the vehicle has kinetic energy to travel further but insufficient energy to reach the next stopping place. The desired result was that the vehicle would stop at the first HHP encountered, i.e., before passing the point of no return, via the service brakes and would maintain levitation. The vehicle traveled north from the station in AUTOMATIC mode at 35 km/h, a speed slower than that necessary to achieve the next HHP. The test was successful, as the vehicle stopped at the first HHP and returned to the charging station.

Test 8:

The goal of this test was to verify the self-correcting capability of the position-location system to maintain proper location of the vehicle if two consecutive INKREFA (wayside vehicle location system) tags are disabled. Two consecutive INKREFA tags were covered with aluminum foil, using the fire truck/cherry picker vehicle, to render them inoperative, and the vehicle traveled north from the charging station. The test was successful, and the vehicle returned to the charging station.

TEST 9:

Test 9 involved three missing INKREFA tags. The desired result was that the vehicle would stop at the next HHP via the service brakes, while maintaining levitation, when three consecutive INKREFA tags were not found. Three consecutive tags were covered with aluminum foil, and the vehicle traveled north from the charging station. The test was successful, as the vehicle stopped at the next HHP, maintained levitation, and returned to the charging station.

TEST 10:

The goal of this test was to verify that coasting in reverse without propulsion results in a Class I emergency stop, setting the vehicle down on the skids. The vehicle was taken to the ramped section of guideway leading to the Halle (preparation for docking position), and at the point of steepest descent, the propulsion system was shut off, allowing the vehicle to coast down the ramp toward the maintenance bay. (The vehicle was programmed that forward direction was up the ramp.) The desired result was that the BLT II system would automatically intervene (after determining that the vehicle was going the wrong way) and stop the vehicle, setting it down on the skids. The expected outcome was not achieved. The vehicle attempted a Class II (not Class I) emergency stop, and tried to apply the service brakes, but since propulsion was removed, the operating brakes were not available. (The attempt to apply brakes was correct and was verified by Siemens additional display equipment). The standby system was activated by the Siemens representative to force the vehicle onto the skids. This manual intervention was not planned. The failure of this test was probably caused by the wrong type of emergency braking being assigned to rollback detection by the application software. The reverse operation was probably encoded as a Class II, instead of a Class I, emergency. Siemens will examine the software to determine the cause of failure and will make the appropriate modifications.

Another discrepancy found in this test was that the vehicle location system apparently had not reset properly after the INKREFA tests were conducted. This inability to reset may have possibly contributed to the apparent variable range violation in Test 2, although the INKREFA tests appeared to give good results.

Monday November 2

The guideway was inspected between Central Control and pillar 557. Guideway measurements were taken using the TR07 operational systems. The control system was checked out at high speeds in preparation for afternoon guest visits and rides.

The Economics Minister and the Environmental Minister visited the Halle and received a demonstration ride on the TR07 vehicle.

Mr. Wiedenmann discussed the types of tests that were performed on October 30. It was unclear whether tests to prove certain requirements of the system had actually been performed. Such tests include verifying propulsion when one feed is lost, maintenance of synchronization when power is lost and then restored or when the vehicle coasts through a dead section, and maintainability of levitation under failed battery pack.

Mr. Wiedenmann described the computer failure (previously discussed under October 28 and 30) that had occurred approximately 2 weeks before the testing during a visitor ride and caused emergency braking and dropping to the skids. Apparently, the source code for the control system can be compiled with a switch which causes it to check the ranges of variables (the sizes/lengths) for each subroutine. If a variable range is exceeded, it is assumed that the overly long variable has overwritten some other data. It is therefore considered a fault. In reaction to this fault, the software sends an interrupt, which is supposed to be handled by the operating system in a certain way. Unfortunately, there was no interrupt servicing routine for this type of interrupt. Thus, the first three-channel computer (FST) went down due to the fault. The second three-channel computer (FSI) took over, but it also failed because it was working with the same data and the same software to process it. Since both of the three-channel computers were down, the entire system went into emergency shutdown.

Consequently, the information about the conditions at the time of the failure was lost. A modification has been made by Siemens to store all information on Electrically Erasable Programmable Read Only Memory (EEPROM) during program execution to allow for a post-mortem investigation of causes of failure in the future.

The FSI and FST computers are identical (and provide for mutual backup) except that one receives information from the DUE (decentral computer). This distinction is accomplished via a jumper on one of them. One-channel failures are tolerable, but failure of two channels causes initiation of emergency (programmed) braking and stopping at the next HHP.

Tuesday November 3

The TR07 vehicle did not run. General maintenance was performed in the Halle. Sensors were re-installed for on-line measurement of stator pack vertical alignment. An additional INKREFA device was installed.

Three films about the TR07 vehicle (mostly promotional) were shown at the Test Facility. One was an overview of the system, another was on noise measurements, and the third was about the technology and guideway construction. The film on noise measurements compared noise figures of the TR07 vehicle with those of the ICE and TGV consists at various distances from the guideway and at various operating speeds. The highest dB(A) figure for the TR07 vehicle at 300 km/h and 50 m from the guideway was approximately 80 dB(A), but was always less than the corresponding figures for high-speed wheel-on-rail consists.

The Task Force observers visited the charging station. Charging is accomplished by electrodes above the guideway that contact similar electrodes on the underside of the vehicle sections. The collectors on the underside are normally inside the vehicle sections and deploy at the charging station. Battery charge is accomplished by three-phase 240-V, 50-Hz power. Two symmetrical five-plate arrangements were noticed; they were located to correspond to the vehicle-borne electrodes or touch-plates. The reason for using five- instead of three-plate arrangements (or four-plate for a star configuration) was not stated. Possibly, the extra electrodes were used for direct charge of the 24-VDC batteries, although it was understood that all power would eventually be supplied by the 440-VDC batteries.

A recently repaired concrete section of the southern loop, where new epoxy for attaching the stator pack fasteners to the guideway had been completed, was visually inspected for damage or any foreign objects or debris left on the guideway. Apparently the epoxy initially used to hold the sleeves into which the bolts are threaded did not have a sufficiently long service life. The old epoxy was blasted out with high-pressure water, and the sleeves were installed with a new epoxy that is supposedly more durable and has a longer service life. The Task Force observers attended this inspection, riding on the maintenance vehicle (Wartungsfahrzeug I) for approximately 3 km.

This maintenance vehicle, which is used for stator pack inspection and maintenance, has parapets on each side where repair and inspection personnel can stand and have access to the underside of the guideway. This vehicle is very slow with a top speed of less than 10 km/h. It has a diesel engine which drives a hydraulic propulsion system for better control of speeds. It also has power generators to power the tools that may be used by the repair crew or to levitate the TR06 vehicle.

Before returning to the Test Center, the maintenance vehicle stopped at Switch 3. Mr. Wiedenmann and the observers climbed up to the guideway and signalled the Central Control operator, via radio, who operated the switch allowing it to be seen in operation. The observers then climbed down to the ground to watch the switch operate in the reverse direction.

A segment of the concrete guideway is painted red to signal the on-board operator that the position of Switch 3 cannot be changed, when the TR07 vehicle is in manual mode, beyond this point. Thus, the operator must know, before passing beyond the red paint, whether the switch is in the correct position to allow passage to the tangent section of guideway.

Wednesday November 4

Guideway measurements were conducted using the TR07 vehicle, and it was prepared for visitor rides. Several rides were conducted for German utilities workers, visitors from DB-Osnabrück, VIPs from Meckleburg/Vorpommen (a German state involved in Hamburg-Berlin route planning), the Federal Minister for Research and Technology (BMFT, H. Witt), and Dr. Krigge.

Hardware and software were installed for the new on-line measurement system for stator pack alignment.

Mr. Wiedenmann and the Task Force observers toured the access road in a car, and Mr. Wiedenmann explained all of the guideway elements on the southern loop, including switch #3, switch safety interlocks, OCS towers, the different types of concrete and steel spans, and gaps. Three emergency walkways (with stairs and ladders) are located along the southern loop. They provide egress from the TR06 vehicle where the guideway is too high to permit the use of rescue slides in case of an unplanned emergency stop. The lowest segment of the guideway (a little more than 1 m above the ground) was enclosed by a 2-m fence topped with barbed wire. This limited protection from vandalism, e.g., objects thrown onto an "at-grade" guideway, may be insufficient for application in the United States. The protective guardrails around the pillars at road/access turns and the OCS towers may also be insufficient for U.S. revenue service. Part of the original access road used during construction of the southern loop had been removed, and the land was being restored to farming.

Thursday November 5

Visitor rides were conducted on the TR07 vehicle. Guideway measurements were taken during the rides. Performance of the step-up chopper was measured. Tests of this newly installed on-line measurement system for stator pack alignment were performed. Control monitoring of magnets was observed. Tests of the INKREFA position-finding system were conducted. Other activities at the Test Facility included maintenance of the 440-VDC batteries of the TR07 vehicle sections, functional tests of the magnetic wheel unit (MRE), monitoring of work on the southern loop (ultrasonic measurements of screw pre-tension), and frequent operation of Switch 3 to investigate conditions at load application points.

It was noted that, as part of the "progress of technology," another substation was planned, to allow for double-feed and to permit more acceleration in the northern Loop. The number of substations (one or two) to be used in Florida has not been decided.

Mr. Blomerius participated in an investigation concerning shutdown of operations on the southern loop following 2 months of test service.

The Task Force observers watched, from Central Control, the beginning and return of a visitor run with the TR07 vehicle on the straight portion of the guideway from the charging station to a point on the northern loop shortly after the straight section enters the curve. The top speed on the beginning of the run was 271 km/h and slightly lower on the return.

Mr. Blomerius stated that he believed that the guideway structure in Florida would be double-span steel, as is the test section on the north-south straightaway at TVE. The reasoning involves the changes in camber caused by air and radiated temperature changes that can, in turn, cause camber to vary as much as 10 mm. He diagrammed the effect of the double span in reducing camber swings to one-third of that of a single span under similar conditions.

Mr. Blomerius then took the observers under the TR07 vehicle and pointed out the location sensors on the guideway and various types of undercar equipment. Then, the observers boarded the vehicle and observed the interior of each vehicle section while the vehicle remained levitated. He also pointed out the location of the main computers used for the OCS and the "auxiliary simple" on-board computer. This computer was used to control the vehicle before the OCS was operational and is still used as a backup during the testing. The mechanism for opening the side (emergency) door was explained. The side door is normally closed, but there is a lever to manually override the system and keep the door open during an emergency. Additionally, a portable gate is used to "block" the doorway if the side door is open. (For example, the side door may be opened during an emergency for ventilation until evacuation is arranged; the gate would be used to prevent people from falling out of the vehicle section.)

Friday November 6

Visitor runs, tests, and maintenance activities conducted on November 5 continued. The Task Force observers accompanied visitors from the U.S. National Transportation Safety Board (NTSB) and Mr. Herrmann of Siemens Erlangen on one of the visitor runs, along a portion of the northern loop. The top speed reached on this trip was 300 km/h.

Monday November 9

No tests were scheduled this week until Thursday and Friday. Mr. Bsdurek, the "Safety Officer" and the coordinator for the different companies that perform maintenance at TVE, pointed out fire safety features of both the TR07 and the TR06 vehicles.

On board the TR07 vehicle, Mr. Bsdurek reviewed the different fire safety features for each section. There are four fire extinguishers inside the passenger vehicle section: two powder and two halon. Their location (between the seats) and type were marked by wall signs directly above the floor locations. The fire extinguishers are recessed in the floor and have covers that preserve the fire integrity of the floor, but they can be easily removed. Next to each of the side doors in the passenger section were two additional fire extinguishers (one powder and one halon), a first aid kit, and two boxes that each contained one of the rope devices kept in back of the VIP passenger seat and smoke filter masks. The test control/monitoring section contained several halon and powder extinguishers, as well as four smoke mask/filtering systems connected to oxygen. Two "fire blankets" were stored on the top of the test equipment. In addition to another first aid kit, there are four wall-mounted boxes at each end of the test section containing oxygen masks for use in a fire by the crew to escape. There were also two blue boxes containing the rope devices and smoke filter masks and two portable orange chairs stored in this section intended for use by elderly or handicapped persons. Mr. Bsdurek stated that during a test, all 48 passengers were evacuated in 3 minutes, using all four devices (also using those devices in the two boxes located in test-instrument section) at each of the doors.

Normal passenger entry to the TR06 vehicle section is provided by two double side doors (as in U.S. transit cars). The seating capacity is 70 passengers, consisting of a middle first class section (with two seats on each side) and two tourist sections (with three and two seating). There are overhead luggage racks. When the TR06 vehicle sections were built, the southern loop did not exist. The height of the rest of the guideway is uniform and permits use of rescue slides at any point. The slides installed in a side wall next to each double door set were high enough for use in an evacuation. A ladder and some rope devices, presumably for use if the TR06 vehicle was operated on the southern loop, were stored in the instrumented vehicle section. Deployment of the rescue slide requires 7-m lateral clearance at a 45° angle. Because high-voltage equipment is kept in the storage compartment of the TR06 vehicle, the storage lockers have a suppression system activator button. The end sections of the control cabs can also be used for evacuation onto the guideway by the crew. For the wider doors of the TR06 vehicle sections, a flexible device consisting of rope webbing between two metal poles is used as door protection for workers when the doors are open. A rigid plastic sheet covered the end of the operator cab of the passenger section. A bird had hit the windshield and shattered the glass. After the glass was replaced (by a stronger type), the plastic was installed as a protective measure; it was also installed on the windshield (which was not replaced) in the other vehicle section. For the TR07 vehicle sections, the next higher level of glass than the replacement was specified. The TR06 vehicle has been involved in two fires: a small one involving a short circuit of air conditioning equipment, and a fire involving the high-voltage equipment which destroyed one of the vehicle sections in 1984 or 1985.

Tuesday November 10

Mr.Bsdurek showed three videotapes of different types of cloth evacuation tubes, one for evacuating a person who is operating warehouse lifting equipment and two for evacuating buildings. The first type is installed under the seat in the floor of lifts used to load equipment on high shelving. If the lift becomes stuck, the operator removes the seat cover and enters the tube to the ground. There is a spiral inner tube and 0.6-m-high zippers located at different heights so that the person can get out even when the lift is stopped at different heights. The next type is a "portable" tube carried in a large bag and attached to a special platform at the end of a fire truck ladder which can be raised to the height of building windows. The fire trucks at TVE respond, if needed, to fires outside the Test Facility (mutual assistance), and the cherry picker fire truck has been approved for equipping with the tube, pending funding. Although the video showed a tube with only an opening at the bottom, Mr. Bsdurek stated that the tube that TVE plans to purchase will have additional openings at various heights. The third type of tube is made by Axel Thom. Mr. Bsdurek "tested" this tube at TVE; he used the tube to exit a second floor window of the building outside the hausmeister office. This tube will be installed and tested on one of the doors of a TR07 vehicle section. The tube will be installed in a compartment located next to the side door, in a space 1 m by 1 m by 30 cm. Mr. Bsdurek also showed a brochure for a fourth type of tube, also made by Axel Thom. It is actually a slide, as it does not have an inner tube and must be deployed at a 45° angle. The bottom end must be attached to permanent in-ground anchors.

Concern was expressed about the tubes' performance in a strong wind. There may not be access at or time for a person to reach the intended landing location to anchor the tube before the first person using it to exit a vehicle section reaches the ground. A strong wind might send an unanchored tube, and the first evacuee, in an unplanned direction. Additional tests are planned.

Mr. Bsdurek then explained the fire safety aspects of the Test Facility. There are 25 lockers with fire coats and helmets and 10 self-contained breathing apparatus (SCBA) units in the fire response/storage room; 25 of the 50 employees have had fire response training. Additional fire extinguishers, extra oxygen tanks, two masks/filters, two rescue chairs, and other equipment are stored. The high-voltage-equipment rooms contain smoke and heat sensors but not automatic suppression equipment. There is a small panel in the fire response/storage room with lights for each area with an alarm system that indicates where a particular sensor is activated. There is also a building diagram indicating which rooms have smoke and fire detectors.

Mr. Bsdurek pointed out the third rail on the guideway section leading into the Halle and the current collectors on the TR06 vehicle sections. The TR07 vehicle sections were not equipped with the "third-rail type" of auxiliary power pickup, a decision questioned by some using hindsight. Inside the Halle, Mr. Bsdurek showed the new type of skid materials for the TR07 vehicle sections, different for the ends and the middles of the skids. He also showed the equipment on the fire truck which has a 2,400-liter water capacity and also carries AFFF foam. The truck is equipped with a top turret which can shoot water 70 m, and has SCBAs and extra tanks, as well as wrecking tools. In the battery room, Mr. Bsdurek pointed out the TR07 battery assemblies, noting that they are much smaller than the TR06 assemblies. He stated that the smaller batteries and other equipment changes had reduced the weight of the TR07 vehicle from that of the TR06 vehicle by about 8 tons. The ladder truck is used as a quick convenient way to allow access to the guideway in addition to the other types of specialized types of guideway equipment.

Wednesday November 11

The inside of the TR07 vehicle sections was observed with the main power system turned off, as work was being done on undercar equipment. Emergency lights are located at the side door exits and the intercar doors. No locations are lighted by emergency lighting within the passenger seating area.

Mr. Bsdurek showed a 1-minute videotape of the deployment of an evacuation slide from a TR06 vehicle section. The slide unfolds rapidly from three segments and has high sides. When fully deployed, the end of the slide extends past the exit road, and the people using the slide are helped into the woods.

Thursday November 12

Mr. Raasch mentioned a plan to use the TR06 vehicle for testing because it offers a better opportunity for testing the guideway geometry.

Three demonstration runs were conducted using the TR07 vehicle. The first included a test of the eddy current brakes, and the passengers were warned to be prepared for unusual occurrences. The other two demonstrations included no testing. Following the demonstrations, a test-only run was conducted with one magnet turned off, to measure the current and voltage generated.

The Task Force observer rode on the TR07 vehicle during the first run. The vehicle reached a top speed of 303 km/h and stopped just past the observation center in Dörpen and then returned at a constant speed of 171 km/h. There was a operator in both the front and rear of the vehicle. There was a pronounced angle to the vehicle when it stopped on a superelevated portion of the northern loop. The visitors were told that not all of the loop was open because of a quality assurance problem--a "low tech," not "high tech" problem. When the train was moving, the windshields were obscured by streams of water, in both forward or reverse operation. (The TR06 vehicle sections had windshield wipers, but they were removed from the TR07 design.)

Friday November 13

The operation of Switch 3 was observed from the walkway. The switch was moved using the local control located in a shed under the switch; under normal operation, the switch is controlled by Central Control. The switch seemed to move slowly when it was opened and stuck when it was moved back. It was then moved back and forth a few more times without problem. Apparently, the switch tends to stick a little because it is not used regularly. Operation of Switch 2 was later observed from Central Control.

Monday November 16

A glimpse of the TR07 vehicle with one of the side panels removed was observed, showing a section with of the lateral guidance magnets and the eddy current brakes. Some of the cables were being repaired, and the vehicle was readied for a visitor run. Near the end of the second leg of the run, without the passengers, a brief emergency "touch down" occurred. It was caused by an unknown propulsion system malfunction. Levitation was immediately restored, and the vehicle returned to the departure bay.

A large portion of the testing during this week involved the nutsteins and the stator pack bolts. It appears that, although the concern about the bolts could be remedied through redundancies in the design, subsequent torque retention tests, and ultrasonic inspection monitoring, the nutstein failure problem could stop operations, as it involves stator packs dropping from the guideway and possibly striking the magnets. Other test activities during this week included various runs to test elements of the propulsion system (such as tests on DAR, which is a digital propulsion control protection unit), continuation of the INKREFA check-out tests, programmed braking tests, and several visitor runs. The on-line INKREFA system was installed during the previous week, but no data were obtained.

The Task Force observer toured the guideway, and viewed and inspected the various steel and concrete guideway constructions, including the high-speed Switch 3. Of special interest was the prototype double-span steel guideway, which may be the prototype for the Florida design. No one at TVE has committed to a "Florida design," as the final proposal is still being prepared. According to Dr. Korb, the 50-m steel beam prototype at TVE was transported there in one piece. This beam has a modified cross section; the traditional tubular bottom longitudinal stringer has been replaced by a 15-mm thick and 40-cm wide rectangular plate. Simplicity and cost were cited as the main reasons for this modification.

It was noted that recently obtained results of a preliminary metallurgical test on broken samples of a nutstein revealed a brittle fracture failure, possibly due to a high hydrogen content. Some of the staff at TVE believed that this problem was caused by poor quality control during manufacture.

Tuesday November 17

Discussion continued with TÜV staff concerning the loss of torque of the stator pack bolts. The entire southern loop has been retrofitted with new stator pack bolts (at a very high cost); they were being monitored with an ultrasonic stress measurement technique. The obvious difficulty with this technique, analogous to the problem encountered in measuring force in continuous welded rail, is that ultrasonic diagnostics require that a "zero stress or initial length" reference condition be known for each bolt, either by measurement or by excellent quality control, to ensure consistent initial microstructure and thus a same zero stress ultrasonic signature.

The basic concept of the new redundancy design has been developed to ensure detection of a dropped stator pack. Another bolt (for concrete) or a slotted steel plate (for steel) will be included, allowing the stator pack to drop 1 to 2 mm. This drop can then be detected by the off- or on-line gap monitoring sensing system before the stator pack falls from the guideway. These redundant systems were being tested on the two prototype steel and concrete beams.

The Task Force observer rode the TR07 vehicle during a visitor run. The vehicle reached 300 km/h. It was noted that the ride quality was rough, possibly caused by a combination of guideway roughness and propulsion control anomalies. The interior noise was considerably louder when the vehicle traversed the steel beam segment.

At the Halle, Dr. Korb described the various concrete and steel guideway types and construction details. There was considerable discussion of the "thermal camber problem," both the positive (convex) and negative (concave), that had been observed at TVE. An upper-to-lower chord temperature difference of 22° K had been measured. This temperature differential could lead to a 10 mm camber change for single span and about 4 mm for a double-span steel beam. The negative camber was observed under some conditions when the beam lower chord was warmer than the upper surface because of ground heat radiation. Dr. Korb noted that the characterization of the thermal load environment in Florida will be very important for guideway geometry assessments. He also noted that "weathering" darkens some of the concrete guideways, resulting in more heat absorption. Dr. Korb and the observer rode to Switch 3 and climbed up on the walkway to look at a special test of the influence of surface coating on the temperature gradient. The surface of a span-length concrete guideway beam was covered with white plastic. The results to date showed a 50-percent reduction in the temperature difference. Dr. Korb stated that the maximum tolerable camber change depended on ride quality tolerance and on penalties in operating speeds.

Mr. Steinmetz expressed a strong preference for double-span guideway beam construction, coupled with an improved stator pack mounting concept--the "Lufthansa" concept, whereby bolts carry the load in shear instead of in tension (as in the current design). Mr. Steinmetz also mentioned another alternative safety approach for the stator pack dropping problem. It involves adding two titanium-strip skid inserts to the vehicle sections' magnet surfaces to act as impact or sliding surfaces that would prevent the magnets from being damaged if a stator pack drops. It was noted that the TR07 magnets have already been redesigned to "bevelled corner," which acts as a deflector if a stator pack drops.

<u>Wednesday November 18</u>

There was no work at TVE in observance of the Buss und Bettag (Penance and Prayer Day) holiday.

<u>Thursday November 19</u>

Dr. Korb explained his assessment of the performance of the new prototype double-span steel beam. Figure 1 shows the cross section configuration for this prototype. Note the flat bottom and the added web stiffener (every 1 m) for added rigidity. Figure 2 shows the conventional double-span steel beam cross section in the northern loop. Figure 3 compares the cross-sections of the steel beams on the northern and southern loops.

Dr. Korb stated that there is limited data on the double-span steel prototype. There is, however, concern about vibration resonance and subsequent noise. Apparently, more mass is required to mitigate the resonance frequencies. The mass of a segment of Switch 2 was increased for this purpose by putting fine gravel into the beam interior. However, because of moisture contamination, either through subsequent water intrusion or through initially wet gravel, internal corrosion resulted.

A film entitled "Der Betonfahrweg" on the construction of the concrete guideway was presented. It showed the concrete beam being poured, reinforced, and cured at the nearby Dywidag plant, and erected on site. Apparently, the main challenge was to ensure the precision and tight tolerance requirements during manufacture of the forms. Figure 4 shows the typical concrete guideway beam cross section. Figure 5 shows the concrete guideway support designs for both straight and curved configurations.

Vergussmortproblem--premature failure of the special epoxy-bonding or casting mortar in the stator pack fastener assembly sleeve--was discussed. Although the casting mortar exhibited good quick setting and hardening characteristics, it subsequently expanded, creating unexpected failures. As mentioned earlier (under November 3), the old epoxy had been blasted out with high-pressure water, and the sleeves installed with a new epoxy that is supposedly more durable and has a longer service life.

<u>Friday November 20</u>

The Task Force observer joined a special test measurement team on a segment of concrete guideway on the southern loop. This segment had exhibited an "exception" by the off-line monitoring sensors, i.e., stator pack alignment deviations larger than 1 mm. Mr. Steinmetz ordered special slow roll-by stator pack alignment variation measurements using the Wartungsfahrzeug I maintenance vehicle. The test consisted of an energized electromagnetic plate being pulled along the bottom surface of the stator pack. The plate provides the same signature as the off-line alignment diagnostics. After several passes of data recording and comparisons with the off-line system output, it became evident that this "static" method roughly duplicated the off-line-based alignment anomaly. However, after a closer look using a straight edge, the deviation could not be detected. It was noted that additional tests will be required to resolve the problem.

Returning from the maintenance site, the maintenance vehicle passed a measurement crew installing permanent benchmarks on the guideway beams and columns to enable easier monitoring of structure movement and settlement. Dr. Korb stated that average settlements were about 3 mm, but a 10-mm settlement was observed at one location.

The soft soil in Florida is a possible concern; expected structure settlement rates may be even larger than those experienced at TVE.

<u>Monday November 23</u>

No runs with the TR07 vehicle were scheduled or conducted on Monday or Tuesday. The vehicle remained in the Halle for continued modification and testing of the operator console computer, fixture modifications to the "b/v-sensor" (the accelerator/velocity sensor package), and calibration studies on the levitation/guidance system. BLT II testing was not scheduled to resume until the week of December 7. The following tests and related activities were conducted:

- Stator pack fastener measurement (torque-wrench method) and damage assessment of a concrete segment of the guideway

- Single-spot diagnostics and replacement of stator pack fasteners in segments of the southern loop and the straightaway

- Ultrasonic monitoring of the prototype redundant stator pack fasteners on the concrete double-span guideway

- Geodesic measurements on all three switches

- "Test-bench" analyses and mitigation of failures of stator pack fasteners, including the nutstein

- Preparation for measurements (to be conducted during the week of November 30) of stator pack fastener loads under hover load conditions

This agenda reveals a very serious concern about the "low-tech" problem of stator pack fastener failure and its evaluation and mitigation. This concern has been consistently reiterated by most IABG and TÜV personnel. This overall problem has three main focus issues:

(1) Damage assessment for all fasteners on the TVE

(2) Control and mitigation through measurements and redundant fault-tolerant designs

(3) Development of new designs, especially for the Florida application

Mr. Decker discussed some new "bench type" tests addressing some of these issues:

- A "temporary fix" design for the nutstein consisting of a clamp assembly over the protruding end of the nutstein

- A load-sharing stator pack design, where adjacent stator packs are hooked together by a channel clamp, enabling an adjacent stator pack to pick up a fastener load lost by another pack and keep it in place

- A first time rational attempt at a mechanistic explanation of the stator pack fastener problem (This is attributed to Professor Mnich, a consultant from the Technical University of Berlin, who asserts that the stator pack has bending cycles that are independent of guideway bending under load. If this theory is true, and tests are currently being planned to verify it, a longer stator pack with an additional fastener in the middle might be recommended.)

Mr. Kuper, Dr. Korb's assistant, showed a sketch of one of the redundant fastener designs currently being trial tested on the prototype double-span steel guideway beam.

Tuesday November 24

Dr. Korb met with the Task Force observer to resolve several questions and issues concerning overall guideway and stator pack behavior. These included the single-span versus double-span camber effects, initial construction tolerances, and the static and dynamic load environment for the guideway and stator packs.

Single- versus double-span guideway beam: Under identical loads, the double-span beam experiences about one-third of the deflection of the single span; however, the stresses in the double-span beam are larger because of central support reactions. (This is why the intermediate column support cross section on the prototype construction has been strengthened.) The trade-offs come in the construction and installation costs, i.e., manufacturing and handling difficulties and tolerances on initial camber designs. For ride quality, the double-span structure is preferred because both loaded (static, vehicle, and thermal) deflections and the effects vehicle/guideway interaction are reduced.

Load assumptions and camber effects: The initial design criteria was very simple in principle, but quite difficult in practice. According to the basic guideway beam design criteria, the initial built-in camber should keep the span longitudinally straight when the beam is subjected to its self-weight, operating vehicle section loads, and the thermal loads. However, in reality these initial cambers compute to approximately 5 mm for a double-span system, and the construction difficulties of realizing this in a 50-m span are great, even without the complication of beam curvature in the lateral direction that is found in the northern loop. Additionally, the influence of thermal effects was underestimated. The initial designs were based on assumptions of 7° K linear top to bottom difference, while in recent 1988 tests, a maximum of 22.5° K was observed. These positive thermal differences (i.e., when the top is warmer than the bottom) produce an additional upward camber change in the guideway. However, more recent experience at TVE had shown instances when the bottom chord was actually warmer than the top chord because of ground radiation effects, resulting in a negative camber. This scenario might be even more prevalent in at-grade or low guideways, which might be proposed in Florida.

Load environment and stator pack fastener failure: The initial load assumption of one cycle per pass of a vehicle section may have not been quite correct. Tests have shown that each magnet (and there are 150 active magnets per side in clusters of ten) is a single cycle, and each cluster of ten produces a peak load on the fastener of approximately 8 kN. Of even greater interest was the new theory or indication that, because of the "swirling" nature of the electromagnetic fields and the interaction of the levitation and propulsion fields, the actual load on the fasteners is three dimensional, i.e., the load also has a lateral and a longitudinal component. These components have not been considered in the design and failure investigations to date. As mentioned earlier, the nutstein failure could stop operations, and apparently testing on the southern loop will not resume until the problem is resolved. Initial indications are pointing to a brittle fracture failure caused by excessive hydrogen content resulting from poor quality control. Nutstein failure and damage assessment is further complicated by the general inaccessibility of the nutsteins and by the existence of various different nutstein designs, as well as "batches of manufacture." Figure 6 shows a diagram of the stator pack, the three-phase windings, the retaining brackets, the nutstein groove, and a sketch of the nutstein.

Mr. Fürst, Dr. Korb, Mr. Kuper, and Mr. Wiedenmann expressed complete faith and confidence in the accuracy and the reliability of the off-line and the on-line gap sensing system to detect a 1-mm stator pack drop or alignment variation, especially in view of the new fault-tolerant magnet design. Final checkout of the on-line system had not been completed.

Wednesday November 25

In a discussion with Mr. Budell at Thyssen Henschel in Munich, the Task Force observer learned that Thyssen does not have a prototype guideway design for the proposed Florida application to send to the designers in Florida. Thyssen has only a spare of an older type design using the "tubular bottom" single-span configuration, and is willing to accept the test results using that configuration. The observer pointed out that in interest of accurate thermal gradient quantification, especially for determining the effects of at-grade ground radiation (an issue in Florida), a prototype flat bottom configuration is essential. As a compromise, the observer suggested modifying or retrofitting the spare tubular bottom design. Mr. Budell agreed to explore that possibility with Thyssen management.

Tuesday December 1

Mr. Blomerius discussed TÜV's review of the status of the nutsteins. He concluded that the bolts had hydrogen embrittlement, a quality control problem. The consensus approach is to search for "low tech" solutions with greater fault tolerance that do not require high strength, i.e., high-hardness bolts that cause manufacturing and quality control problems. The problems to date demonstrate the need for reliable, as well as safe, systems. The biggest problem in that regard is that each subsystem can stop the entire program, delaying testing activities and compromising planned tests. The design for Florida has not been established; a "cold redundant" nutstein or stator pack fastener will be required.

Wednesday December 2

Mr. Blomerius mentioned that the speed limits in curves are defined by the lateral acceleration which is limited to 1.5 m/sec^2 during visitor runs, and that up to 3.5 m/sec^2 could be used for special high-speed runs providing the wind is less than 7 m/sec. The 1.5 m/sec^2 lateral acceleration ride comfort limit is higher than had been assumed and is higher than the wind limit for this operation needs to be. Testing of the nutsteins of suspect stator packs was observed on the southern loop. Three defects were found. Because not all packs were tested and a random sample was used, it seems reasonable to conclude that more failures exist. A work crew was observed on the northern loop installing instruments to measure the loads on the bolts fastened to the beams in the highly superelevated curves. The "wind wall" was viewed. It also has some noise barrier characteristics, but it seemed to act as a sound board and amplifies the noise if anything.

Mr. Steinmetz discussed the stator pack inspection techniques and how the 1-mm drop would be detected. He described the measuring system as a several-MHz electromagnetic pulse that detects the steel surface of the stator pack. The linear synchronous motor (LSM) coil is nearly transparent to the beam, and can be removed electronically. The gap is measured at every mm or 1,000 times over the length of a stator pack. The measurement must be done at speeds above 60 km/h. The 1,000 data points are then used to fit a third-order spline approximation to the surface of the stator. Certain filters and other techniques are used to eliminate noise from the signal and apparently from the stator coil grooves. The end values of each stator are then compared with the adjoining stator, and the difference is compared with a stored baseline value. If the various runs were made at nearly the same speed, under the same wind conditions, etc., the values should be within 0.6 mm of each other. Even when speeds are different, changes of 1 mm are readily apparent. Mr. Steinmetz showed a case where the difference was originally about 1 mm and over several months had become zero, indicating a problem. He stated that with the larger sample, each gap between stators, as well as the LSM grooves and the larger gaps at the end of the beams, is seen. The computer has a table of spline functions for each stator pack, with the end values as initial conditions. Currently, all the 1,000 data points for each stator are stored and processed off-line to evaluate problems in terms of cold redundancy. If the system were on-line, the points would not be stored; only the equation and the end values would be stored. The spline functions can also be compared to determine which of the two adjoining packs has the suspect bolts; the pack with the different spline function is the one with the failure. It is not clear that this method is currently used to evaluate stator packs; however, it could be a useful technique. Mr. Steinmetz suggested that the goal was for all of the stators to be within 0.3 mm of each other, so that an absolute change in gap could be used as an indicator. However, this might not be the most cost-effective solution, particularly if the ride comfort is acceptable at the lower tolerances. He also mentioned that this measuring system allows a look ahead active control that might make a lower frequency cut-off more practical.

The nutsteins were also discussed, as well as the desire to radically change the mounting design to eliminate the tension carrying load and to replace them with a shear system. This type of change will probably be made for the Florida application, although no one at TVE could say for sure. Some sort of cold redundancy will have to be required for the Florida application.

The measuring system described by Mr. Steinmetz could use any of the gap sensors and could be applied to the guidance rail. Currently, only one sensor is used per side of each vehicle section. The sensor is located approximately in the center of the length of the side.

Dr. Korb's assistant showed a document containing a detailed schedule of the guideway inspections and an outline of what is inspected on the guideway, including the sliding surfaces. The document appears to be quite relevant to the Florida application.

The Task Force observer inspected the prototype double-span beams again. The steel beam is much lighter than the concrete beam, 35 tons versus about 95 tons for single 25-m spans. Because the steel beam is so light, sections of it vibrate at the pole motor passing frequencies rather than at vehicle section passing frequencies. Apparently, some internal ballast is being considered to reduce the noise radiation. This seems to negate the advantages of the steel sections, that they are sufficiently light to make the structure more efficient.

Thursday December 3

The Task Force observer rode the TR07 vehicle, at speeds up to 260 km/h up the Kanalstrasse section and into the northern loop. Part of the loop was closed for work on the stator pack fastening. The general purpose of the run was to check the INKREFA-ortung; however, a group from a Paris airport was on board for a demonstration. The ride was a little rough, and there was a hum. Dr. Schmitz stated that the ride is best at high speed. The tests were intended to check whether the system, including the position information, would return to service correctly after the power was shut off. All equipment appeared to work correctly.

Friday December 4

Three work crews were conducting torque tests of the bolts on the main channel track. The testing is awkward and cramped, and it is difficult to envision how the procedure might be automated. The top of the guideway showed signs of age, and there was evidence of previous maintenance activities, such as the grout work for the fasteners on the concrete sections. The sliding surfaces were very smooth, the result of the polishing procedure, and were slightly beveled at the beam gaps. The stator packs showed signs of rust and even de-lamination, although probably not enough to be a safety concern. The coils had numerous nicks and cuts in the insulation, also not a direct safety concern as long as the ground fault detection circuits work properly. There was a spring loaded rubber pad covering the attachment bolt hole on the guideway, presumably to prevent water intrusion, apparently the reason for the extensive treatment on the surface above each attachment point.

A Thyssen Henschel crew was checking nutstein hardness on the southern loop. They used the Wartungsfahrzeug I maintenance vehicle. The Task Force observer learned that this vehicle had been used to lay out the stator windings during TVE construction and was subsequently modified to serve as a maintenance vehicle. The working area can be tilted up to about 8° so that the crew is tilted only 4°, even on curves. The work platforms lower hydraulically and showed signs of much use. The inner ends of the nutsteins were sanded along one side of the guideway, a pre-setup instrument was applied to the ends, making ten measurements at each nutstein. Each measurement was recorded automatically. Ten packs were measured, and the ends of the nutsteins were painted.

Monday December 7

Special last minute maintenance was performed on the linear generator and battery charging system of the TR07 vehicle. The system on board was decentralized, and the power conditioning modules were being modified, although the purpose was not apparent. Tests of the linear generator were planned for later in the week. When either loop is closed at TVE, it is difficult to run the vehicle, as it cannot spend enough time at speed to charge the batteries, forcing a stop at the charging station between runs for wayside power. Apparently, charging only begins at 150 km/h, not at 100 km/h as previously thought. The improved and decentralized charging control units combined with new magnets, scheduled to be installed in the near future, will enable the linear generator to provide net power at 100 km/h.

The bolt inspection continued, and installation of the nutstein redundancy on the southern loop began. Installation of the bracket depends on the ends of the nutsteins, as it connects the ends to the guideway beam. The bracket installed on the southern loop may not work in all cases because of nutstein failure where several pieces are formed and because the pieces are not long enough to adequately support the stator. For example, in one of the failures, two pieces were formed between the bolt and the end of the nutstein.

The longitudinal gap between all the stator packs was measured. The gap is nominally around 2 to 3 mm. However, with corrosion and peeling paint, many of the packs have a friction fit and may not drop down even if a bolt fails, particularly if the adjacent pack can carry some of the load. In the northern loop, installation of special C clamps was being planned to connect packs at the ends of beams to help support the packs that do not have neighbors to restrict their drop. In general, the friction fit and these C clamps are assumed to allow more than the 1-mm drop but probably less than 10 to 15 mm. Thus, the magnet bogie changes are required for extended operations (due to start in February). The leading magnet bogie has the end pole on its side and is protected from the guideway by a hard plastic shield that is bevelled about 20 mm over a longitudinal distance of approximately 50 mm.

Mr. Blomerius and two associates from TÜV began acceptance testing of the OCS by simulation, beginning with systematic checkout of the OCS (theoretically) exercising every branch of the program. As previously noted, simulations are an important part of acceptance, for some branches cannot be reached (safely) and a large matrix of possible vehicle section and guideway states must be verified.

Tuesday December 8

The TR07 vehicle remained in the Halle for the remaining simulation acceptance testing of the BLT II system software by TÜV and Siemens. The powered runs portion of the remaining testing began in the afternoon and was completed on the following day.

Mr. Blomerius discussed the redundancy solution to the stator pack fastening system. In addition to the nutsteins, the bolts are possible failure points. If a single bolt becomes loose, the other bolt on that nutstein will probably fail within as few as 10 train passes. A single bolt failure cannot be detected because the other three bolts keep the stator from moving. The prototype redundancy should protect against failure of either the bolt or the nutstein and should not depend on residual functioning of the nutstein end.

A detailed report on the acceptance of the prototype double-span beams was due from Thyssen Henschel to TÜV by the end of December. TÜV would then study the report and findings and issue a report stating an opinion. Both reports will be made available to the FRA. Regardless of whether the double-span steel is the ultimate proposal, details and discussions of the tests conducted on these designs will be helpful in evaluating and accepting the Florida design.

Mr. Blomerius, Mr. Steinmetz, and Dr. Korb explained the redundant system that has been approved for the southern loop. The system was installed on a small sample piece of guideway in the Halle. Special load deflection tests were conducted on the TR07 vehicle to verify the distance which the stator pack could be expected to fall and the amount of plastic deformation seen in the fixture. Under static loads of 9 to 10 kN, the fixture deflected about 1 mm and remained elastic. This was considered to be acceptable even when the initial 1-mm drop is included. Under more severe loads of up to about 35 kN, the deflections grew to more than 2.5 mm and took a permanent set of about 1.2 mm, which would definitely produce a measurable change. The on-board system would look for 2 indications of failure in any 20 measurements before calling for action. This system provides redundancy for the bolts and a portion of the nutsteins. However, the system provides no protection from a total failure of a nutstein such that the piece that extends from the stator pack can no longer support the stator. The prototype system, while safe, may lead to maintenance problems. On the double-beam guideway sections, the system is too stiff with no damping, subjecting the bolts and nutsteins to dynamic loads that are too high. Methods that carry the loads in shear rather than in tension--the Lufthansa solution--may be preferable.

The Task Force observer watched the work crew restore Switch 3 to operation. During simulations, the switches are controlled by sensor input to the computer, not by the actual hardware. In preparation for the actual OCS testing, the switches need to be returned to service. For the hydraulic Switch 3, this involves some effort. A special key is removed from Central Control and brought locally to the switch, where there are manual controls for operation. With all of the pumps operating and all of the controllers warmed up, the switch was thrown. The mechanical lock is the central flap; the flaps on the sides are simply for the sliding surfaces. While the switch was being cycled, one of the actuators failed sufficiently to cause an emergency shutdown of the switch because of a lack of synchronism. To recover, the on-board operator pulsed the beam back to the straight position using his judgement, although it was unclear how he could determine whether the beam was being over stressed.

Inspection of these types of switches, either hydraulic or electromechanical, will take time and will require training. The safety system and the switch operating system each have more than 20 sensors, and each switch will have at least 5 actuators. The various mechanisms of these actuators would have to be inspected periodically, and some of the sensors would have to be tested. The recovery methods employed when a switch is stopped by synchronism failure may need to be addressed, although theoretically the system will protect itself.

The hydraulic pumps use various pressures depending on the load required. The only mechanical positive lock on Switch 3 is the flap at the fixed beam connection. For the other switches, each actuator has a mechanical lock. For Switch 3, this is accomplished by pressure and valves. In addition, the pumps must be energized at all times. If the pumps lose power, a safe condition is only guaranteed for a brief time.

During the OCS testing in the Halle, there was an unprogrammed stop; the cause was not apparent to the observer.

Wednesday December 9

The powered runs portion of the BLT II and OCS acceptance testing continued. It involved the application codes and special hardware associated with the Central Control system safety computers (FSI, FST, and FUE) for the wayside/Central Control of vehicle speed and guideway switches. TÜV considers these acceptance tests as "preliminary": the test plans and results generated by Siemens had not been made available to TÜV, and the tests at the higher speeds cannot be performed until the southern loop is re-opened for operation in 1993. The 115 BLT II "preliminary" acceptance tests performed in October on the on-board computer codes experienced approximately 20-percent failure.

Additional parallel activities (Parallelaktivitäten) for the TR07 systems during the remainder of the week included periodic maintenance of the 440-VDC battery system, functional testing of the MREs, and installation and testing of the newly developed decentralized battery charging system, which uses a step-up chopper.

The guideway (Fahrweg) activities included continued ultrasonic inspection and re-tensioning efforts on the stator pack bolts in the southern loop under the direction of Dr. Korb and the IABG QS group.

The levitation magnets of the TR07 vehicle sections were examined after the vehicle returned from operations, as were two of the redundant stator pack fastener designs, which were set up on a stator pack test fixture for load cycling.

The Task Force observer noted that final acceptance testing by TÜV appeared to be delayed, and it was not clear how much actual progress had been made toward completing this testing during the past 2 years. It was noted that TÜV was preparing a final report on the present status of the TR07 system for the Ministry of Research and Technology. This may be an interesting document for the Task Force to review, although its direct applicability to the Draft Rule for Florida is not clear.

Based on a meeting held during the preceding week with Thyssen representatives, the final qualification tests on the new magnets were scheduled to be completed before January 1, 1993. Plans were to install four of the new magnets, one at each of the end corners of each vehicle section, by the middle of February 1993. In the meantime, the geometry of the existing magnet ends had been contoured to deflect a partially dropped stator pack upward.

Relative to the nutstein issue, IABG is initiating its own design modifications to resolve the stator pack fastening problem on the southern loop in parallel with Thyssen's efforts to find a solution.

Thursday December 10

Additional power runs with the TR07 vehicle were conducted to perform guideway and system control measurements. Category II and V visitor rides were also conducted.

The battery facility was visited to observe the periodic maintenance being performed on the TR07 battery system. Each of the four battery units contains 344 individual Ni-Cad cells. Each cell provides approximately 1.2 V and has a rated capacity of 37 AH (ampere hours). However, the actual or effective capacity of Ni-Cad cells can be severely reduced below their rated value by regular partial discharges followed by recharging. After a number of these cycles, the cells usually develop a memory, which can reduce the effective cell capacity to a level well below the rated discharge value. To correct this effect and restore these cells to their original capacity, they must periodically be fully discharged (down to approximately 1.0 V) and recharged. The initial maintenance cycle for the batteries was every 90 days. The current maintenance cycle is every 6 months, and the goal is to extend this cycle to once a year. During regular battery maintenance, the cells are inspected for sufficient electrolyte and signs of leakage or corrosion.

During two of the visitor runs on the TR07 vehicle, the Task Force observer monitored the battery charging and discharging displays. The batteries begin charging between 110 and 120 km/h and start discharging once vehicle speed drops below approximately 150 km/h. The battery current drain while levitated at zero forward speed ranged from 6 to 14 A. Below approximately 100 km/h, the average current drain was about 100 A.

Dr. Konigorski of Thyssen reviewed the design features for the new levitation magnets and the new gap control system that are being installed on the TR07 vehicle. The existing (original) levitation magnets on the TR07 vehicle sections were designed around a vehicle section target weight somewhat lower than the actual weight. Therefore, these magnets have been required to operate outside the optimum (linear) portion of the "B" versus "H" curve, resulting in higher currents and operating temperatures. The magnets consist of an iron core surrounded by several loops of aluminum ribbon. The new magnets are being constructed with additional core material and therefore will be approximately 20-percent heavier than the original units, but the percentage of increase in vehicle section weight would be much less. The new magnets are expected to operate more efficiently at both a lower temperature and current. The primary suspension for the new magnets will also be modified.

The present gap control system is designed to share sensors between adjacent magnet packs to permit continuous operation over the "infinite gap" discontinuities that are present between each of the guideway sections. Each half magnet pack has a single sensor located at the open end. Figure 7 shows a half magnet pack removed from a vehicle section with the single sensor housing located on the left side. The sensor housing has been sloped to allow lifting of a dropped stator pack, if encountered. Figure 8 shows a side view of the sensor housing as mounted in the vehicle section. The new gap control system will incorporate dual sensors at each end of each magnet set to allow each magnet set to react more independently of adjacent units. The location for one set of these dual sensors is shown in Figure 9. This new gap control system, along with reduced vertical and longitudinal stiffness, is expected to improve the vehicle's ride response at lower speeds.

The MREs, which include the power supplies and logic control electronics for both the levitation and lateral control magnets, were examined and discussed. The control boards for these units are also being modified for the new magnets and gap control system. Dr. Konigorski conducted a brief tour of the area where periodic functional testing of both the MREs and the gap control electronics is performed. Figure 10 shows the MRE functional testing equipment, and Figure 11 shows the testing fixture for calibrating the gap sensor system.

<u>Friday December 11</u>

Power runs with the TR07 vehicle to perform guideway and system control measurements continued, as did Category III and V visitor rides.

When the vehicle reached the passenger station, the batteries were charged via the special Stromschiene charging device. Wayside power is fed into the vehicle through a series of electrical brushes, which are extended to the top of the guideway from under the vehicle section. There are five rows of brushes, three for the 3-phase power and two rows that serve as contact interlocks and ensure that physical contact is made with the guideway strips before power can be applied. Since the charging currents are in the order of 1,000 A, this approach is used to prevent arcing between the brushes and the guideway strips. When charged, the vehicle operates between the passenger loading station and a point approximately 9 km away in the northern loop. Speeds in the northern direction were limited to about 250 km/h. Speeds during the return trip did not appear to exceed 170 km/h. Except for the addition of the Stromschiene power control switches and monitoring equipment, the BLT I and BLT II control panels, readouts, and video displays appeared to be essentially the same as those observed in 1990.

<u>Saturday December 12</u>

The Task Force observer looked at the stator pack attachments installed on the steel guideway section of the eastern portion of the northern loop. Although it was difficult to see any details from the ground, moderate amounts of surface corrosion were observed on portions of the vertical sides of the guideway, which serve as the reaction surface for the vehicle's lateral guidance system. Figure 12 shows an example of this condition for this portion of the guideway.

<u>Monday December 14</u>

Included in the weekly TVE schedule was acceptance testing of the modified function incorporated in the on-board operator's joystick, the newly installed battery and charging system, the new low-noise data buss system, the optimization of the programmed braking, and the limitations of the eddy current braking system. Mr. Wiedenmann stated that the modified joystick function testing was not part of the scheduled acceptance testing by TÜV, but was being performed for MVP.

Mr. Achter (IABG), who is responsible for periodic maintenance being performed on the TR07 battery system, discussed the new charging system and testing and installation of new batteries in the TR07 vehicle sections. Normal charging of the batteries is provided from the linear generator windings within the levitation magnet cores. A step-up chopper provides the necessary voltage for charging. The existing system charges the batteries at less than full voltage. This was to guard against possible "out gassing" of the batteries resulting from over charging. The new system will allow the batteries to be charged to full voltage using a peak detection circuit. Once a Ni-Cad battery reaches full charge, the cell voltage will drop slightly before over charging and eventual out gassing occurs. The detection of this change in the voltage-time slope can be used to stop charging or reduce the charge rate to a "trickle" or maintenance charge rate. Mr. Achter also mentioned that the original batteries would be replaced after approximately 4 years of use. Prior to installation, each new cell is individually tested for capacity by first fully charging and then discharging at the "1C" rate of 37 A. The cells are monitored for high internal resistance and are rejected if such resistance is found. The first units to be replaced are the 24-V units that are used to power systems other than the levitation and guidance magnets. The new battery units will no longer require the extra one-cell space for housing the temperature sensor for monitoring battery temperature.

The Task Force observer visited the area, in the Halle, where IABG was investigating its "interim fix" redundant fastener designs for the stator packs. Both the S-shaped side plate and the U bolt hanger designs were present. Figure 13 is a photograph of the C-channel clamp that is being considered as a means of limiting the distance that a loose adjacent stator pack can drop.

Tuesday December 15

The first series of environmental tests on the redundant fastener parts for the southern loop were scheduled to begin at TVE, but were held at another facility, instead.

During the first series of runs with the TR07 vehicle, the programmed braking functions of the system to stop the vehicle within approximately $\pm$ 1/2 m of a specific location at the passenger station were fine tuned. A series of these test runs were witnessed from Central Control; the video monitor for the passenger loading station was used to observe the stopping reference marks on the side of the vehicle sections. The results obtained were outside the maximum desired limits. However, it appeared that the under shoot was repeatable and therefore may be corrected by adjusting the relative location of the stop reference (bias), either on the vehicle sections or on the guideway. The Task Force observer believed that the on-board operator manually performed the precise positioning of the vehicle.

Wednesday December 16

The acceptance testing of the modified joystick function began. According to Mr. Wiedenmann, the original joystick deflection prescribed a force "thrust or drag" level and not a speed or acceleration value. The new function allows a desired speed to be "dialed" in and also (he believed) the acceleration rate at which the target speed is reached, within the power limits available.

During the first series of low-speed joystick test runs to the north, the TR07 vehicle lost propulsion and had to be set down on the skids by the on-board operator. It was not clear whether this was an actual loss of wayside power or a loss of synchronization between the vehicle and the guideway. Several additional runs were observed, and were conducted without incident at various speeds up to approximately 260 km/h for a range of acceleration levels. Observed variations between the indicated versus targeted speed values were normally $\pm$ 1 km/h. No over speeds were witnessed.

Mr. Steinmetz reviewed the suspension system parameters of the TR07 vehicle sections, including the lateral deflection requirements for negotiating curved portions of the guideway. The approximate body section length of 25 m will allow a minimum turning radius of approximately 400 m. To tolerate this, each of the magnet bogies must have a lateral deflection of about $\pm$ 100 mm. The current vertical stiffness (primary suspension) between the levitation magnets and bogie is on the order of 10×10^6 N/m. Mr. Steinmetz said that both the vertical and longitudinal stiffness for the new magnets will be reduced, but offered no values. The vertical natural frequency is currently around 200 Hz and occurs at approximately 200 km/h. The lateral resonance frequency occurs between 70 and 80 km/h.

The stator pack fastener issue and the associated loads were also discussed. The steady-state or mean vertical load on each stator pack is on the order of 15 kN. Superimposed on this is a $\pm$ 20-percent alternating (dynamic) loading. For the existing four-bolt configuration, each bolt would experience an in-line force of approximately 0.3 metric ton. Apparently, the dynamic mode shapes of the stator packs can generate pitching moments and associated forces at the attachment points that can add to reduce the fatigue life of the fasteners.

Finite element analyses addressing the stator pack deformations and optimum cross-sectional shape for the nutstein slots have been performed for the prototype double-span steel beam by Thyssen and others over the last couple of years. One paper published by K.F. Rother at Thyssen, The Optimization of the Stator Pack Attachment for the Guideway of the Maglev, was obtained at a finite element analysis seminar and is appended to this report as the third attachment.

Finally, Mr. Steinmetz discussed the stator pack measurement system and the operational gap clearance between the guideway and the vehicle. The accuracy of the off-line measurement system of the TR06 vehicle was 0.5 mm. The accuracy of the current off-line system for TR07 vehicle is 0.7 mm. The new on-line system, which is expected to be operational by the middle of 1993, is expected to have an accuracy of 1.0 mm.

The current operational gap between the guideway and a vehicle section varies between approximately 9 and 13 mm, with the maximum occurring at speeds below 100 km/h. The gap variation with the new magnets is expected to be much less, between 7 and 8 mm, throughout the speed range.

Thursday December 17

The day's runs with the TR07 vehicle included a final series of tests of the programmed braking. During one of the runs at low speed, propulsion was lost, and the vehicle had to be set down on the skids. Although not a safety concern, the recurring loss of propulsion could become an operational problem during normal revenue service. Figure 14 is a photograph of one of the skids, taken after the vehicle returned to the Halle.

The Task Force observer estimates that TÜV is at least a year from completing its final acceptance testing of the modified TR07 system. Given that the full southern loop can be operational by Spring of 1993, the new magnets and gap control systems will need to be fully exercised and evaluated. The results obtained from the preliminary acceptance testing on the BLT II system need to be resolved with Siemens. Additionally, continuous simulated revenue operation of up to 6 months will need to be completed.

APPENDIX A

Weekly Test Schedules

IABG INTERN

TM-M-315/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
De/ha	Lathen	16.10.9[illegible]

Wochenprogramm für die 43. KW (19. bis 23.10.92)

TERMINE
Randbemerkung
Erledigungsverme[illegible]

Montag, 19.10. und Dienstag, 20.10.92

Kein Fahrbetrieb!

o	TR07-Hallenbetrieb	
-	Fortsetzung der BLT II-C1-Abdeckungstests im Simulationsbetrieb (Rückbau der BLT II-Simulationseinrichtung am Dienstag von 18.00 bis 20.00 Uhr)	Siemens / HH. Otto, [illegible]
-	Modifikation der Tragspalt-Sensorik in den Bug-MRE's zur sofortigen Erkennung von etwaigen Statorlageänderungen	TH H. Klesing
-	Fortsetzung der Reparatur der Schäden am Wagenkasten	Fa. Albers H. Willenb[illegible]
-	Überprüfung des Schutzleiterkonzepts der Fahrpulte	TH H. Berwang[illegible]
-	Überprüfung der Bugklappenbefestigungen	TH H. Hörburg[illegible]
-	Überprüfung der Befestigung der Unterbodenverkleidung in den Bugbereichen	"
-	Fortsetzung der Probemontage der neuen Magnetinnenverkleidung	TH H. Hempel[illegible]
o	Fahrweg	
-	Überprüfung von Statorbefestigungen im Bereich der Südschleife, an W2, an den Trägern 250 und 384	H. Kuper QS, H. Aut[illegible]
-	Erprobung einer auf dem Wfz. II installierten Meßeinrichtung (SPS-Schlüssel) zur Schraubenkontrolle	H. Thiele QS, H. Fu[illegible]
-	Reparatur des Elastomerlagers auf St. 2121	

TMA

Fürst

Mitzeichn. (Name)

- Überprüfung der Meßsensorik an St. 2224 — H. Nieters

Mittwoch, 21.10.92

ab 8.00 Uhr

guideway portions / control system

o Inspektion des Fahrwegbereiches VZ-Südschleife-Kanaltrasse-Westzweig Nordschleife bis Tr. 557, mit gleichzeitiger Funktionskontrolle der Streckensperre bei Tr. 550 mit dem TV — H. Stein, H. Thiele

track closing / simultaneous

ab 9.00 Uhr bis Freitag

o TR07-Antriebsfahrten

guideway survey

- zur Fahrwegvermessung — H. Nieters

pursue

- zur Fortführung des Programms: — H. Müller

intentional fault

Messungen am Stator 11 des Tr. 306 mit gewollter fehlerhafter Primärbefestigung (Nutsteinschraube gelöst bei Überfahrten mit höherer Geschwindigkeit)

screw unfastened from higher speed

step up stream

- für Messungen an Hochsetzstellern der Lineargeneratoren — TH, H. Grüb

determining efficiency drive

- zur Bestimmung des Wirkungsgrades η des Langstatorantriebs — H. Behrends

loaded vehicle movement (hunting)

- zur Messung der Schlingerlasten — H. Klein

- für Untersuchungen über die Störfestigkeit von DMS geklebt an St. 2224 — H. Nieters

und

- zur Demonstration (s. Besucherliste)

Parallelaktivitäten:

o TR07

maintenance of

- Wartung der 440V-Batterien — H. Achter

fault search and repair as soon as detect the function of

- Fehlersuche und Fehlerbehebung sowie Funktionsprüfung im Prüflabor — H. Schmid, H. Schaap, H. Zinselme

- Studien über die Schalldämmung der Struktur des Wagenkastens (Schalldurchgangsmessungen - sie finden in der Halle statt, beginnen am Mittwoch um 18.00 Uhr, setzen sich fort am Donnerstag ab 18.00 Uhr, Freitag ab 17.00 Uhr und enden am Samstag) — DASA, H. Dr. Brü, H. Dr. Schm o Antrieb

Inbetriebnahme des SHL für die Übertragung von Meßdaten von den Schaltstellen zum Unterwerk — H. Meyer

o Fahrweg

- Reparatur von Schäden an der Gleitleiste im Bereich Beton 1. BA Ostzweig — Fa. D&W

- Reparatur der beschädigten Kabelwicklung an Tr. 428 (nur Montag und Dienstag) — Fa. Kabelmet

- Vermessungsarbeiten bei gleichzeitiger Umstellung des Meßverfahrens für die Lage- und Höhenbestimmung der Trasse (im Bereich St. 557 bis 630 nur Montag und Dienstag) — Fa. Marx

- mehrmals täglich Verstellung der W3 für Untersuchungen an einzelnen Stellgliedern — H. Deymann, H. Brameyer

Für folgende Mitarbeiter wird Mehrarbeit bzw. versetzte Arbeitszeit beantragt:

Mehrarbeit HH. Stein, Thiele

"früh/spät"

HH.	Körner	Mundil
	Krüssel	
	Achter	Willenborg
	Knoop	Brameyer
	Thesing	Lambers
	Zinselmeyer	Schmid

Ausblick auf KW 44 und 45:

Fahrbetrieb!

Montag, 26.10. bis Freitag, 30.10.92

o TR07-Antriebsfahrten (zur Verfügung stehender Fahrweg; Montag und Dienstag mit Südschleife, übrige Wochentage ohne Südschleife)

- für Messungen an einem Stator mit imperfekter Primärbefestigung

- für Teilabnahmen von BLT II-Komponenten durch den TÜV (ab Dienstag, 11.00 Uhr) und

- zur Demonstration

o Fahrweg

- Fortsetzung mit der Prüfung an den Statorbefestigungen in der Südschleife (am Mittwoch bis Freitag)

Montag, 02.11.92

Besuch des Wirtschaftsministers und des Verkehrsausschusses des Landes Schleswig-Holstein

Mittwoch, 04.11. oder Donnerstag, 05.11.92

Besuch des Wirtschafts- und Umweltausschusses des Landes Mecklenburg-Vorpommern

gez. Decker

IABG INTERN

TM-M-328/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
De/ha	Lathen	23.10.92

Wochenprogramm für die 44. KW (26. bis 30.10.92)

TERMINE
Randbemerkungen
Erledigungsvermerke

OCT 26

Montagvormittag

ab 8.00 Uhr

o Inspektion des Fahrwegbereiches zwischen VZ und Stütze 557 mit Funktionskontrolle der Streckensperre auf Tr. 550 mit dem TV — H. Stein, H. Thiele

gleichzeitig

o TR07-Hallenbetrieb

- Vermessung der Trag- und Führmagnete — H. Mundil, H. Lambers
- Überprüfung des Hochsetzstellers 4LL-II — H. Thesing

ab 10.00 Uhr

o TR07-Antriebsfahrten

- zur Fahrwegvermessung

und

- zur Demonstration (s. Besucherliste)

Montagnachmittag

o TR07

- Justage (mech.) der Trag- und Führmagnete — H. Lambers, H. Willenborg

TMV	TMA	Stelle
Steinmetz	Fürst	Mitzeichnung (Name)

TERMINE
Randbemerkungen
Erledigungsvermerke

Dienstag, 27.10.92 OCT 27

o TR07-Antriebsfahrten

- zur Fahrwegvermessung

und

- zur Demonstration (s. Besucherliste)

noch Dienstagnachmittag

- Vorbesprechung über die Durchführung der BLTII-Teilabnahmeprüfung durch den TÜV — TÜV, SB, H. Metzner

ab 16.00 Uhr

o TR07

- Aufbau der Testumgebung für den BLT II-Simulationsbetrieb — SB, H. Wöbbeking

Mittwoch und Donnerstag OCT 28, OCT 29

Kein Fahrbetrieb!

o TR07

- Abnahmetests der BLT II: — TÜV, SB, H. Metzner

  Überprüfung von statischen Funktionen mit Hilfe der Simulationseinrichtung (Fzg. - Übertragung - Leitstand - Antriebsregelung bereit; während der Tests dürfen keine weiteren den Ablauf störenden Versuche durchgeführt werden)

und Donnerstagabend

- Rückbau der BLTII-Simulationseinrichtung — SB, H. Wöbbeking, H. Metzner

Freitag, 30.10.92 OCT 30

o TR07-Antriebsfahrten

- Fortsetzung der Abnahmetests der BLT II: Überprüfung von Funktionen im Normalbetrieb — TÜV, SB, H. Metzner

TERMINE Randbemerkungen Erledigungsvermerke

Parallelaktivitäten:

o TR06

- Tausch einer 24V-Fzg.-Batterie — H. Achter, H. Opfermann

o TR07

- Fortsetzung der Wartung von 440V-Batterien — H. Achter
- Fehlersuche und Fehlerbehebung sowie Funktionsprüfung von MRE's im Prüflabor — H. Schmid, H. Schaap, H. Zinselmeyer
- Überprüfung der Stromabnehmer — H. Schmitz, H. Willenborg

o Fahrweg

- Kontrolle der Statorbefestigungen im Stahl und Beton des 2. BA — H. Kuper, QS, H. Auth
- Untersuchung einiger Statoren im Fahrwegbereich 2. BA bei denen eine verspannte Einbaulage vorliegen könnte
- Reparatur des Elastomerlagers auf St. 2121 Mi + Do
- Vermessungsarbeiten im Stahl Nord (im Bereich von St. 557 bis 630 nur Mittwoch und Donnerstag) — Fa. Marx
- Weitere Untersuchungen von redundanten Statorbefestigungen, den sog. C-Schienen, für den Stahl Nord — H. Stein, H. Thiele
- X Statorausdrückversuche zur weiteren Qualifizierung der Redundanzbefestigung an dem Zweifeldträger (nur Mittwoch und Donnerstag) — H. Lambers, H. Willenborg
- mehrmals tägliche Verstellungen der W3 für Untersuchungen an einzelnen Stellgliedern H. Deymann fragen — H. Deymann
- Änderung einiger Sonderstatoren am Tr. 2426 und 2427 (Halbzahn entfernen etc.), da sie sich bei der online-Statorüberwachung als störend erweisen — H. Thiele, QS, H. Auth

o Antrieb

- Umbau eines Schaltwagens (Einbau von Spannungswandlern etc.) — H. Behrens, H. Brameyer

TERMINE Randbemerkungen Erledigungsvermerke

o Allgemein

- Durchführung eines "updates" an der Basman-Meßanlage (Donnerstagvormittag) — H. Metzner

- Betriebsbesichtigung der Berufsgenossenschaft (Kontrolle: Einhaltung der Unfallverhütungsvorschriften; Mittwoch) — H. Bsdurek

Ausblick auf KW 45

Montag, 02.11.92 NOV 2

Besuch der Wirtschaftsminister und des Verkehrsausschusses des Landes Schleswig-Holstein

Mittwoch, 04.11. oder Donnerstag, 05.11.92

Besuch des Wirtschafts- und Umweltausschusses des Landes Mecklenburg-Vorpommern

Weiter noch zur Erledigung anstehende Aufgaben:

- Erprobung des online-Meßsystems im höheren Geschwindigkeitsbereich
- Ausschwebeversuche (Bestimmung des Wirkungsgrades η des Langstatorantriebes)
- Messungen an Hochsetzstellern der Lineargeneratoren
- Lastmessungen an Tr. 306 und 2224

gez. Decker

IABG INTERN

TM-M-337/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-45
Akten- und Diktatzeichen	Ort	Datum
De/schr	Lathen	30.10.92

Wochenprogramm für die 45. KW 92 (02.11. bis 06.11.92)

TERMINE

Montag, den 02.11.92

ab 8.00 Uhr:

o Inspektion des Fahrwegbereichs zwischen VZ und Stütze 557 mit Funktionskontrolle der Streckensperre auf Träger 550 mit dem TV — H. Stein, H. Achter

gleichzeitig

o Rangieren des Wartungsfahrzeuges II vom Träger 60 auf den Parkträger II — H. Thiele

ab 10.30 Uhr

o TR07-Antriebsfahrten

- zur Fahrwegvermessung anschließend einige schnelle Fahrten zur Systemkontrolle.

ab 13.30 Uhr

o TR07 steht in der Halle für den Besuch des Wirtschaftsministers Herrn Thomas mit Begleitung, Herrn Thormählen aus dem Ministerium für Natur und Umwelt sowie Damen und Herren des Wirtschaftsausschusses - alle aus Schleswig-Holstein - bereit. — TH/MVP

14.30 Uhr

o TR07-Demonstrationsfahrt

danach

o TR07-Antriebsfahrt als Vorbeifahrt (Hin- 300 km/h, Rückfahrt 150 km/h).

TM

Steinmetz

Dienstag, den 03.11.92

Kein Fahrbetrieb !

o TR07-Hallenbetrieb

- Wartung allgemein — H. Körner
- Einbau der modifizierten Sensoren für das online-Meßsystem — TH, H. Bub
- Einbau einer INKREFA-Zusatzeinrichtung — TH, H. Zylka

o Fahrweg

9.00 Uhr: Besprechungsraum VZ, 2. Stock
Einführungskolloquium

<u>Thema:</u> Billig-Redundanzen für Statorbefestigungen des TVE-Fahrweges

HH. Künzel
Steinmetz
Dr. Wedemann
Kuper
Pieper
Thiele
Stein
Willenborg
Decker

ab 14.00 Uhr:

- Sichtkontrolle des gerade sanierten Bereiches Beton Ostzweig Nordschleife auf Fremdkörper und Beschädigungen

HH. Kuper
Stein
Thiele, N.N.

Mittwoch, den 04.11.92

o TR07-Antriebsfahrten

- zur Fahrwegvermessung
- zur Vorbereitung für die anstehenden Anlagendemonstrationen

Danach

um 10.00 Uhr:

- Besucherfahrt für eine Gruppe der Stadtwerke Solingen — Gem. Lathen

um 10.30 Uhr:

- Besucherfahrt für Damen und Herren der DB Osnabrück und weiteren Gästen. — H. Hugenberg

ab 11.00 Uhr:

o TR07 steht in der Halle für den Besuch des Ausschusses für Wirtschaft und Umwelt des Landtages Mecklenburg-Vorpommern bereit. — MVP

11.45 Uhr:

o TR07-Demonstrationsfahrt

anschließend

o TR07-Antriebsfahrt als Vorbeifahrt

14.30 Uhr:

o TR07-Antriebsfahrt

- für Besucher (H. Witt vom BMFT und Begleitung)

15.00 Uhr:

- für Besucher (H. Dr Knigge mit Begleitung und weiteren Gästen)

16.00 Uhr bis 19.00 Uhr:

o Installation der Hard- und Software für das online-Meßsystem

Donnerstag und Freitag (05. und 06.11.92)

o TR07-Antriebsfahrten

- zur Fahrwegvermessung
- für Messungen an einem Hochsetzsteller eines Lineargenerators — TH, H. Grüb
- für Tests am Sensor für das online-Meßsystem — TH, H. Bub
- für das online-Meßsystem allgemein — AEG, H.v.Gabler
- zur Regleroptimierung — TH, H.Ellmann
- zum Test der INKREFA-Erweiterungseinrichtungen — TH, H. Zylka

und

- zur Demonstration der Anlage (s. Besucherliste).

Gleichzeitig wird ein Filmteam Aufnahmen für einen "Imagefilm" über den TÜV-Rheinland machen.

Meßaufgaben wie sie lt. Programm für Donnerstag vorgesehen sind, können auch bei den Mittwochsfahrten durchgeführt werden.

Parallelaktivitäten

o TR07

- Fortsetzung der Wartung von 440 V-Batterien — H. Achter

- Funktionstests von MRE's im Prüflabor — H. Schmid, H. Schaap, H. Zinselmeyer

o Fahrweg

- Kontrolle der Statorbefestigungen im Stahl und Beton des 2. BA — H. Kuper, QS, H. Auth

- Untersuchung einiger Statoren im Fahrwegbereich 2. BA, bei denen eine verspannte Einbaulage vorliegen könnte.

- Behebung von Mängeln, die bei der letzten Kontrolle auf dem Stahlfahrweg 1. BA festgestllt wurden (nur Dienstag im Bereich Stütze 557 bis Stütze 630). — H. Kuper, QS - H. Auth

- Vermessungsarbeiten Stahl Nord (im Bereich von Stütze 557 bis 630 nur am Dienstag). — Fa. Marx

- Abdichtung einer Leckage, Überprüfung von Rücklauffiltern etc. an Weiche 3 — H. Pieper

- Mehrmals tägliche Verstellungen der Weiche 3 für weitere Untersuchungen an einzelnen Stellgliedern. — HH. Deymann, Pieper

Für folgende Mitarbeiter wird Mehrarbeit bzw. vesetzte Arbeitszeit beantragt:

Mehrarbeit: HH. Stein, Thiele

"früh/spät"

HH.	Körner	Mundil
	Krüssel	
	Achter	Willenborg
	Knoop	
	Thesing	Lambers
	Zinselmeyer	Schmid

Ausblick auf KW 46:

Montag, 09.11. bis Mittwoch, 11.11.92:

Kein Fahrbetrieb !

o **TR07**

- Anbringung von Ausschnitten in die Fahrpult-Chassis IABG
- Änderung und Neuverlegung von Kabeln in Vorbereitung auf die Modifikation des Fahrhebels TH
- Test der Fahrhebelfunktionen der DAR im Simulationsbetrieb (am Mittwoch) SE IABG

o **Fahrweg**

- Kontrolle der Statorbefestigungen entsprechend der Schädigungstabelle im 1. BA

und Montag

o Einweisung in die Bedienung der neuen Meßanlage IABG

Donnerstag und Freitag

o TR07-Antriebsfahrten

Die in der 44. KW vom TÜV begonnenen Abnahmetests finden zu einem späteren Zeitpunkt ihre Fortsetzung. TÜV SB

gez. Decker

IABG INTERN

TM-M-345/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
De/schr	Lathen	06.11.92

Wochenprogramm für die 46. KW (09.11. bis 13.11.92)

TERMINE
Randbemerkungen
Erledigungsvermerke

Montag, 09.11. bis Mittwoch, 11.11.92

o **TR07**

- Anbringung von Ausschnitten in die Fahrpult-Chassis — HH. Körner, Lambers
- Änderung und Neuverlegung von Kabel in Vorbereitung auf die Modifikation des Fahrhebels — TH, H. Berwanger, H. Mützel
- Test der Fahrhebelfunktion der DAR im Simulationsbetrieb (am Mittwoch) — H. Meyer
- Inspektion des "Meldepfades" des Wirbelstrombremskreises 8 — TH, H. Sattler
- Mechan. Spaltabgleich bei den Trag- und Führmagneten — H. Mundil
- Unterfütterung der restlichen Tragkufen, deren Dicke die untere Grenze erreicht hat — H. Lambers

o **TR06**

Mittwoch, den 11.11.

15.00 Uhr:

Besprechung: Raum VZ, 2. Stock
Thema: Wiederinbetriebnahme TR06

HH. Steimetz, Körner, Mundil, Opfermann, Otto, Meyer, Behrends, Dr. Korb, Decker

o **Fahrweg**

- Kontrolle der Statorbefestigungen, entsprechend der Schädigungstabelle im Bereich Beton 1. BA (Kanaltrasse) — H. Kuper, QS - H. Auth, Fa. Marx
- Vermessungsarbeiten an Weiche 1 und Weiche 2

TERMINE
Randbemerkungen
Erledigungsvermerke

Donnerstag, den 12.11.92

8.00 Uhr:

o Abheben der Gerüste im Bereich der Kanaltrasse — H. Stein

gleichzeitig

o Inspektion des Fahrwegbereiches VZ und Stütze 557 mit Funktionskontrolle der Streckensperre auf Träger 550 mit dem TV. — HH. Thiele, Achter

ab 10.00 Uhr:

o TR07-Antriebsfahrten

- zur Fahrwegvermessung
- zur Justage des Sensors für das offline-Meßsystem — HH. Mundil, Müller

und

- zur Demonstration der Anlage (Besucherfahrten mit der Schlüsselzahl 4).

Freitag, 13.11.92

o **TR07-Antriebsfahrten**

Fortsetzung der Aufgaben von Donnerstag

<u>Parallelaktivitäten:</u>

o **TR07**

- Fortsetzung der Wartung von 440 V-Batterien — H. Achter
- Funktionstests von MRE's im Prüflabor — HH. Schmid, Zinselmeyer

o **Fahrweg**

- Fortsetzung der Kontrolle der Statorbefestigungen im Fahrwegbereich 2. BA — H. Dr. Korb QS, H. Ziegeltrum
- Durchführung von Restarbeiten im Bereich Beton Nord Ostzweig — Fa. D&W

- Beseitigung von Mängeln (Gewährleistung) an der Böenmeßwand (Montag bis Mittwoch) — Fa. Thyssen-Kölnne

- Behebung der bei der 100 %-Kontrolle festgestellten Mängel im Stahl Nord (zwischen 557 und 630 nur an den Tagen Montag bis Mittwoch). — H.Kuper, QS, H.Auth

- Erstellung von Muster, den sog. Billig Redundanzbefestigungen für sämtliche Fahrwegtypen. — H. Pieper, H. Willenborg, H.Stein, H. Thiele

Für folgende Mitarbeiter wird Mehrarbeit bzw. versetzte Arbeitszeit beantragt:

Mehrarbeit: HH. Stein, Thiele

"früh/spät"

HH.	Mundil	Körner
	Willenborg	Krüssel
	Brameyer	Achter
	Lambers	Thesing
	Schmid	Zinselmeyer

<u>Ausblick auf KW 47:</u>

Montag, 09.11. und Dienstag, 10.11.92

o TR07-Antriebsfahrten

Mittwoch: **B u ß t a g !!!**

Donnerstag, Freitag sowie bei Bedarf auch am Samstag (hier nur bei abgerüstetem Fahrzeug):

o TR07

- Modifikation des Fahrhebels

Die in der 44. KW vom TÜV begonnenen Abnahmetests werden in der 50. KW wie folgt fortgesetzt:

07.12.92:

Vorbesprechung, Aufbau der Testumgebung für den BLT II-Simulationsbetrieb und Abnahmetests der BLT II.

08.12.92:

vormittags:

Fortsetzung der Tests im Simulationsbetrieb.

nachmittags:

Tests im Normalbetrieb

09.12.92

tagsüber:

Tests im Normalbetrieb

gez. Decker

IABG INTERN

TM-M-350/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
De/be	Lathen	13.11.92

Wochenprogramm für die 47. KW (16.11. bis 21.11.92)

TERMINE
Randbemerkungen
Erledigungsvermerke

Montag, 16.11.92

ab 8.00 Uhr

o Inspektion des Fahrwegbereiches zwischen VZ und Stütze 557 mit Funktionskontrolle der Streckensperre auf Träger 550 mit dem TV — H. Stein, H. Achter

ab 10.30 Uhr

o TR07-Antriebsfahrten

- zur Fahrwegvermessung und Systemkontrolle
- zum Test der optimierten Zielbremse — H. Meyer
- für abschließende Messungen an der erweiterten INKREFA-Einrichtung (hier sind gesonderte Fahrspiele erforderlich) — TH, H. Zylka
- für Studien über den neuen Beschleunigungsbegrenzer in der DAR — H. Meyer

  und

- zur Demonstration (Besucherfahrten mit der Schlüsselzahl 2, um 11.30 Uhr sowie der Zahl 4 um 14.30 Uhr)

Dienstag, 17.11.92

o TR07-Antriebsfahrten

- zur Fortsetzung des Programms vom Montag
- für weitere Demonstrationen
  (Besucherfahrt mit der Schlüsselzahl 3 um 11.30 Uhr)

TMV

Steinmetz

Stelle

Mitzeichnung (Name)

- für Dreharbeiten für einen Serienfilm "The Dreamfactory" des Belgischen Fernsehens (ab ca. 11.00 Uhr) — H. Bsdurek

Mittwoch, (Buß- und Bettag)

- Kein Versuchsbetrieb

Donnerstag, 19.11.92

(Versuchbetrieb bis 20.00 Uhr bei aufgerüstetem Fzg.) — Koordinatoren: TH - H. Fsicher IABG: HH. Körner, Metzner

- Koordination

o TR07-Fahrhebeländerung

ab 9.30 Uhr

- Ausbau des Diagnoserechners und Beginn mit der Modifikation desselben — TH, HH. Knauer, Steube
- Ausbau des Fahrpultrechners in der Sek II und Wiedereinbau eines mod. Ersatzrechners — TH, HH. Berwanger, Mützel
- Ausbau, Modifikation und Wiedereinbau des Fahrpultrechners in der Sek I — HH. Berwanger, Mützel

ab 13.00 Uhr

- Test der Fahrpultrechner im Fzg. — TH, H. Dr. Kiesewetter, H. Wendt

Freitag, 20.10.92

(Versuchsbetrieb bis 16.00 Uhr)

o TR07

  - Weiterführung des Tests vom Vortage

ab 14.00 Uhr

  - Test der Schnittstelle für die Fahrhebelfunktionen zwischen Fzg. - BLT II und Antrieb — HH. Berwanger, Körner, Metzner, Behrends

Samstag, 21.11.92

(Versuchsbetrieb bis 15.00 Uhr bei abgerüstetem Fzg.)

o TR07

- Erprobung der beiden Fahrpultrechner und des Diagnoserechners im Testbetrieb — TH: H. Dr. Kiesewetter, H. Wendt IABG: H.Metzner

TERMINE Randbemerkungen Erledigungsvermerke

Parallelaktivitäten

o TR07

- Fortsetzung der Wartung von 440 V-Batterien — H. Achter
- Funktionstests von MRE's im Prüflabor — HH. Schmid, Zinselmeyer

o Fahrweg

- Ausbau weiterer Nutsteine im Fahrwegbereich Stahl 2. BA die bei der Ultraschallprüfung ein auffälliges Verhalten zeigten — QS - H. Ziegeltrum
- Fortsetzung der Kontrolle der Statorbefestigungen im Fahrwegbereich 2. BA — H. Dr. Korb, QS - H. Ziegeltrum
- Behebung der bei der 100 % Kontrolle festgestellten Mängel im Stahl Nord (zwischen 557 und 630 nur an den Tagen Donnerstag und Freitag) — H. Kuper, QS - H. Auth
- Kontrolle der Schrauben der Redundanzbefestigung am Zweifeldträger Beton (nur am Donnerstag und Freitag) — H. Kuper
- Vermessung der W1, W2 und W3 (W1 u. W2 nur am Donnerstag und Freitag) — Firma Marx
- Studien über das Verhalten des Offline-Sensors beim Überfahren des Tr. 2303 (ab Donnerstag mit dem Wfz. I nach Prüfanweisung v. H. Steinmetz) — HH. Auth, Schmid, Zinselmeyer
- Aufbau einer Prüfeinrichtung u. erste statische Vorversuche an den Mustern der sog. Billig-Redundanzbefestigungen — HH. Pieper, Willenborg, Stein, Thiele

Für folgende Mitarbeiter wird Mehrarbeit bzw. versetzte Arbeitszeit beantragt:

"früh/spät"

H. Körner	H. Mundil
H. Krüssel	H. Willenborg
H. Achter	H. Brameyer
H. Thesing	H. Lambers
H. Zinselmeyer	H. Schmid

TERMINE
Randbemerkungen
Erledigungsvermerke

Ausblick auf KW 48

Montag und Dienstag,

- Kein Fahrbetrieb!

o TR07

  - Fortführung der Aktivitäten:
    Modifikation des Fahrhebels (Die Fahrhebelfunktion steht erst wieder ab Dienstag voll zur Verfügung)

  - Einbau einer LWL-Strecke in Sek. I für Eingangstests für ein künftiges Bussystem

Mittwoch, Donnerstag und Freitag,

o TR07-Antriebsfahrten

  - dabei am Mittwochvormittag, in erster Linie Inbetriebnahmetests der modifizierten Systemfunktionen

gez. Decker

IABG INTERN

TM-M-354/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Otto	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
Ot/ha	Lathen	20.11.92

Wochenprogramm für die 48. KW (23. bis 27.11.92)

TERMINE
Randbemerkungen
Erledigungsvermerke

Montag, Dienstag: TR07-Hallenbetrieb

Montag

- Fortsetzung Modifikation Fahrpult-/Diagnoserechner incl. Test	TH, H. Fischer H. Berwanger

Dienstag

- Fortsetzung Modifikation Fahrpult-/Diagnoserechner	"
- Anbringen einer neuen Halterung für b/v-Sensor	TH, H. Klesing
- Justage Trag-/Führsystem	H. Mundil

Mittwoch - Freitag: Fahrbetrieb

Test vehicle

Mittwoch

ab 8.00 Uhr

- Gerüste auf 1. BA absetzen/Inspektionsfahrt mit TV zwischen VZ und St. 537	H. Thiele

ab 16.00 Uhr

- Kontrolle des PRW-Signals bei sich bewegendem abgesetztem Fahrzeug (dazu TR07 einige Male bei v ~ 5 km/h am Bahnhof absetzen)	H. Meyer

übrige Zeiten am Mittwoch, Donnerstag, Freitag

- Messungen an der Tragspaltsensorik	TH, H. Ruppert
- Fortsetzung Messungen am Hochsetzsteller	TH, H. Grüb

step-up anwenden (chopper)

TM
Steinmetz

Stelle

Mitzeichnung (Name)

- Spannungs-Messungen an einem Bremsmagnet — TH, HH. Wok, Steube

- Einbau/Test der LWL-Strecke für LAN-Versuch — TH, H. Knauer

begleitend

- Zielbremsfahrten (Halt am Einstieg) — H. Meyer

Geplante Besucherfahrten

Mittwoch:	11.30 Uhr	14.00 Uhr
	14.30 Uhr	15.00 Uhr
Donnerstag:	11.00 Uhr	11.30 Uhr
	12.00 Uhr	14.30 Uhr
Freitag:	11.00 Uhr	11.30 Uhr
	12.00 Uhr	

Parallelaktivitäten:

Fahrzeug:

- Wartung 440V-Batterien — H. Achter, H. Zinselmeyer, H. Schmid

- Funktionstest von MRE's

Fahrweg:

- gemäß Anlagen "Fahrwegarbeiten TVE" vom 19.11.92

Besondere Arbeitszeitregelung

Für folgende Mitarbeiter wird Mehrarbeit bzw. versetzte Arbeitszeit beantragt:

"früh/spät"

H. Körner	H. Mundil
H. Krüssel	H. Willenborg
H. Achter	H. Brameyer
H. Thesing	H. Lambers
H. Zinselmeyer	H. Schmid

Ausblick:

KW 49:

- 2 Tage Erprobung Statorredundanz (Standschweben mit TR07 auf Parkträger VZ-Süd)
- Fahrbetrieb (Zielbremsfahrten?)

KW 50:

- Montag - Mittwoch: Fortsetzung TÜV-Abnahme BLT II (schwerpunktmäßig BLD)
- Donnerstag, Freitag: Abnahme Zielbremse / PRW-Erweiterung?

Otto

IABG INTERN

TM-M-361/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	Ort	Datum
De/schr	Lathen	27.11.92

Wochenprogramm für die 49. KW 92 (30.11. bis 04.12.92)

TERMINE
Randbemerkungen
Erledigungsvermerke

Montag, 30.11.92

ab 8.00 Uhr:

o Inspektion des Fahrwegbereiches zwischen VZ und Stütze 480 mit Funktionskontrolle der Streckensperre auf Träger 480 (neu) — H. Stein, H. Achter

ab 9.30 Uhr:

o TR07-Antriebsfahrten

- zur Fahrwegvermessung und Systemkontrolle
- zum Test des umgebauten Fahrhebels

und

- zur Demonstration der Anlage (Besucherfahrten der Schlüsselzahl 5 um 10.30 Uhr, 14.00 Uhr und 14.30 Uhr). — H. Hugenberg

Ab 16.00 Uhr:

o Anbau einer Kamerahalterung am Bug der Sektion I — Filmteam Stoiber, H. Lambers, H. Willenborg

Dienstag, 01.12.92

o TR07-Antriebsfahrten

- zur Fahrwegvermessung
- für Dreharbeiten für einen Cinema-Scope-Film und — Filmteam Stoiber
- für Besucher mit der Schlüsselzahl 4, um 11.30 Uhr und 14.30 Uhr. — H. Hugenberg, H. Bsdurek

		Stelle
f. TM	TMV	
Fürst	Steinmetz	Mitzeichnung (Name)

Mittwoch, 02.12. und Donnerstag, 03.12.92 (vormittags)

o TR07-Antriebsfahrten

- für weitere Untersuchungen der Zielbremsfunktion (jeweils Zielhalt an der Einstiegsplattform und im Norden auf Träger 477) — Siemens Erl., H. Dr. Eckhardt, H. Meyer

- zur Kontrolle der INKREFA-Ortung und zur Demonstration (Besuch von Damen und Herren der Universität München, Prof. Dr. Haas sowie Vorstand von Aeroport de Paris; Donnerstag um 11.00 Uhr). — H. Meyer, TH H. Rausch

Donnerstagmittag bis Freitag, 04.12.92 (14.00 Uhr)

o TR07-Hallenbetrieb

- Fortsetzung der BLT II-C1-Abdeckungstests im Simulationsbetrieb (Fahrzeug, Leitstand, Antrieb und Funk aktiv).

Für die Antriebsfahrten steht uns nur der Fahrwegbereich zwischen VZ und Stütze 480 zur Verfügung (damit V_{max} = 280 km/h), sonst gelten die gleichen Festlegungen wie in den zurückliegenden Wochen.

<u>Parallelaktivitäten</u>

o TR06

- Tausch einer 440 V-Batterie — H. Opfermann, H. Thesing, H. Brameyer

o TR07

- Wartung von 440 V-Batterien — H. Achter, H. Schmid, H. Schaap, H. Zinselmeyer

- Funktionstests von MRE's — TH, H.Dr.Kiesewette, H. Wendt, H. Berwanger

- Tausch von Hardwarekomponenten und Einbau einer Überwachungseinrichtung beim Diagnosesystem — TH, H.Dr.Kiesewette, H. Wendt, H. Metzner, H. Körner, H. Kratz

- Einweisung in die Funktion der Diagnose- und Fahrpultrechner (am Dienstag)

o Fahrweg

- Weitergehende Untersuchungen an der Statorbefestigungen im Fahrwegbereich 2. BA — QS, H. Ziegltrum

- Messung der jeweiligen Lage der sog. y-Bleche zu den freien T-Nuten der Statoren im Stahl Nord — H. Kuper

- Kontrolle der Statorbefestigungen entsprechend der Schädigungstabelle im Bereich 1. BA zwischen Träger 83 und Träger 146 — H. Kuper, QS, H. Auth

- Ultraschallprüfung der Statorbefestigungsschrauben an den Prototypträgern — QS - H. Auth

- Säuberung der Durchbrüche für die Spannanker im Betonfahrweg 1. BA — H. Kuper

- Anbringung, Prüfung und Kalibrierung von DMS an Träger 558 (A8) — IABG, Lichtenau, H. Dr. Korb

- Ausbau von Statorpaketen incl. deren Befestigungselemente aus dem Stahlfahrweg 1. BA zur Ermittlung der Betriebsfestigkeit der Schrauben auf dem Prüfstand — H. Kuper, H. Auth, H. Stein

Besondere Arbeitszeitregelung

Für folgende Mitarbeiter wird Mehrarbeit bzw. vesetzte Arbeitszeit beantragt:

"früh/spät"

HH.	Mundil	Körner
	Willenborg	Achter
	Brameyer	Knoop
	Lambers	Thesing
	Schmid	Zinselmeyer
		Krüssel

Ausblick auf KW 50

Montag, 07.12.92

o TR07-Hallenbetrieb

- Vorbesprechung und Aufbau der Testumgebung für den BLT II-Simulationsbetrieb für die folgenden TÜV-Abnahmetests

Dienstag, 08.12. und Mittwoch, 09.12.92

o BLT II-TÜV-Abnahmen im Simulations- und im Normalbetrieb

Donnerstag, 10.12. und Freitag, 11.12.92

o TR07-Antriebsfahrten

TERMINE
Randbemerkungen
Erledigungsvermerke

KW 51

Montag, 14.12. bis Freitag, 18.12.92

TR07-Antriebsfahrten!

- für Messungen an einem Hochsetzsteller eines Lineargenerators
- für Eignungstests eines neuen Bussystems etc.

gez. Decker

IABG INTERN

Att. 1

TM-M-370/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
De/schr	Lathen	04.12.92

TERMINE
Randbemerkungen
Erledigungsvermerke

Wochenprogramm für die 50. KW 92 (07.12. bis 11.12.92)

CW 50

Monday Tuesday

Montag, 07.12. bis Dienstag (mittags), 08.12.92

o TR07-Hallenbetrieb

- TÜV-Abnahmetests der BLT II im Simulationsbetrieb (simulator) (Vorbesprechungsbeginn: Montag, 8.00 Uhr) — TÜV, H.Dr. Krebs; SB, H. Eilers; HH. Otto, Metzner
- Systemkontrolle des Trag-/Führsystems — H. Mundil
- Inspektion 2-er Rollanker im Führen — TH, H. Hoerburger; H. Lambers

o Rangieren des Wartungsfahrzeuges II (maintenance) vom Parkträger II (parking track) auf den Anbinderfahrweg mit anschließenden Tests der Antriebsaggregate (Montag, ab 10.00 Uhr). — Fa. Messung, H. I. Schmitz

o Fahrweg

- Fortsetzung der Kontrolle der Statorbefestigungen entsprechend der Schädigungstabelle im Bereich der Kanaltrasse von Träger 100 bis Träger 140 (nur am Montag). — H. Kuper; QS - H. Auth

o Abheben der Montagegerüste im Bereich der Kanaltrasse (Dienstagmorgen) — H. Stein

danach

o Inspektion (sweeper train) des Fahrwegbereiches zwischen VZ und Stütze 480 mit dem TV. — H. Stein; H. Achter

Tues afternoon Wed

Dienstagnachmittag ab 14.00 Uhr und Mittwoch

o TR07-Antriebsfahrten (powered runs) — TÜV, H.Dr.Krebs; SB, H. Eilers; H. Otto

- für BLT II-TÜV-Abnahmen (Acceptance tests)

TM
Steinmetz

Thurs Fri
Donnerstag und Freitag

o TR07-Antriebsfahrten Powered runs

- zur Fahrwegvermessung und Systemkontrolle
  Guideway measurements
  und
  Runs Visitor runs (rides)
- zur Demonstration der Anlage (Besucherfahrten der Schlüsselzahl 3 und 5 am Donnerstag, 10.00 Uhr, 10.30 Uhr, 14.00 Uhr und 14.30 Uhr sowie am Freitag um 10.30 Uhr, 11.00 Uhr und 11.30 Uhr). — MVP H.Hugenberg H.v. Berkum Gem. Lathen und Dörpen

Parallelaktivitäten Parallel activities

o TR07 Maintenance of Battery System

- Wartung von 440 V-Batterien — H. Achter
- Funktionstests von MRE's Functional testing of magnet control units (MRE) — HH. Schmid, Schaap, Zinselmeyer, TH, N.N.
  Charging equipment change
- Tausch von LEM-Wandlern in den Hochsetzstellern
  Install + Test new developed
- Einbau und Test einer neu entwickelten BG für eine dezentrale Batterieladeregelung im Hochsetzsteller — TH, H.Hamlescha H.Schmid
  Step-up chopper decentralized [illegible]

o Fahrweg Guideway

- Weitergehende Untersuchungen an den Statorbefestigungen im Fahrwegbereich 2. BA — IABG-QS
- Weitere statische Belastungsversuche an Musterteilen der Nullserie für die Redundanzbefestigung für Stahl-Süd — HH. Pieper, Willenborg
- Anfertigung erster Musterteile der weiterentwickelten Redundanzbefestigung für Stahl Nord — HH. Dulich, Krüssel, Stein, Thiele
- Anbringung, Prüfung und Kalibrierung von DMS am Träger 558 (A8) — IABG-Lichtenau H.Dr. Korb
- Montage einer Sonderbefestigung für die Seitenführschiene bei Träger 557 — H. Kuper
- Reinigung der Entwässerungsrinnen (Montag: Kanaltrasse, ab Dienstag: Ostzweig Nordschleife) — H. Kuper
- Maßaufnahme y-Blech - freie T-Nut der Statoren Stahl Nord — H. Kuper

Randbemerkungen Erledigungsvermerke

Besondere Arbeitszeitregelung:

Für folgende Mitarbeiter wird Mehrarbeit bzw. versetzte Arbeitszeit beantragt:

"früh/spät"

HH. Körner, Achter, Knoop, Thesing, Zinselmeyer, Krüssel, Mundil, Willenborg, Brameyer, Lambers, Schmid

Ausblick auf KW 51

Montag, 14.12.92 bis Donnerstag, 17.12.92

o . TR07-Antriebsfahrten

- für Messungen am LIG-Hochsetzsteller — TH
  linear generator battery charging
- für Eignungstests eines neuen Bussystems — TH
  data buss system
- zur Abnahme der mod. Funktionen des Fahrhebels sowie der Beschleunigungsbegrenzung (am Mittwoch). — MVV, TH, IABG
  function of JOYSTICK to more closely follow prescribed velocity profile.

Freitag, 18.12.92

Kein Fahrbetrieb ! NO operation

o TR07 — TH

- Einbau Ladeenderkennung und Inbetriebnahme — mounting device to which end of battery charging and place in operation
- Reparatur einer Türsteuerung — Fa. Bode — Repair of one door control

Decker

Decker

Att. 2

TM-M-377/92

IABG-Betriebsmannschaft

Abteilung	Bearbeiter	Telefon
TM	Decker	62-39
Akten- und Diktatzeichen	**Ort**	**Datum**
De/schr	Lathen	11.12.92

Wochenprogramm für die 51. KW 92 und 52. KW 92
(14.12. bis 23.12.92)

TERMINE
Randbemerkungen
Erledigungsvermerke

Montag, 14.12.92

ab 8.00 Uhr:

visual inspect. Guideway section between TVE

o Inspektion des Fahrwegbereiches zwischen VZ und Stütze 480 mit dem Sonderfahrzeug. Test Facility & Pillar #480
special vehicle

ab 10.30 Uhr

o TR07-Antriebsfahrten Powered runs

Guideway meas. system control

- zur Fahrwegvermessung und Systemkontrolle und
- zur Demonstration der Anlage (Besucherfahrten der Schlüsselzahl 5 um 11.30 Uhr, 14.00 Uhr und 14.30 Uhr). visitor rides — H. Hugenberg, Gem. Lathen, H. v. Berkum

Dienstag, 15.12., Mittwoch, 16.12. und Donnerstag, 17.12.92

o TR07-Antriebsfahrten Powered runs

- zur Fahrwegvermessung Guideway measurements — TH, H. Grüb
- für Messungen am LIG-Hochsetzsteller Linear Gen battery charging
  usability (feasibility) step up choppers
- für Eignungstests eines neuen Bussystems to reduce noise pollution — TH, H. Fischer
  of new Buss System for information network
- zur Optimierung der Zielbremse — SE, Dr. Eckhardt; SB, H. Burkert; IABG, H. Behrends
  Opti of programmed braking
- zur Abnahme der mod. Funktionen des Fahrhebels sowie der Beschleunigungsbegrenzung (am Mittwoch, ab 10.00 Uhr - 5 Versuchsfahrten lt. Programm) — MVP; TH, H. Wadle; IABG; Herr Behrends
  acceptance of mod. function; function of Joystick; limitation of acceleration; Wed; according to a special program

TMV Steinmetz	TMA Fürst	Stelle / Mitzeichnung (Name)

measurement Levitation gap sensors
- für Messungen an der Tragspaltsensorik und — TH, NN

Tues
- zur Demonstration der Anlage (am Dienstag Besucherfahrten mit der Schlüsselzahl 2 und 3 um 10.30 Uhr, 11.00 Uhr, 11.30 Uhr, 14.00 Uhr und 14.30 Uhr). — TH, TRI, MVP, H. Hugenberg Gem. Lathen, H. v. Berkum

Freitag, 18.12.1992

Betriebsversammlung ! meeting of all TVE employees

o TR07-Hallenbetrieb in House

installation + operation of indication of end of charging of Batterys
- Einbau und Inbetriebnahme einer Ladeenderkennung — TH, H. Becker

- Reparatur einer Türsteuerung Door Control Repair — Fa. Bode

access covers
- Demontage der großen Seitenverkleidungen und Neulackierung derselben. Dismounting Repainted — Fahrzeug-mannschaft Fa. Albers

KW 52 (21. bis 23.12.1992)

Montag, Dienstag und Mittwoch

Kein Fahrbetrieb ! No operations

Aktivitäten:

o TR07:

- Wartung und Inspektion maintenance & Inspection

o weitere Aktivitäten

s. Punkt Parallelaktivitäten

Donnerstag, 24.12., Freitag, 25.12. und Samstag, 26.12.1992:

verantwortlich hierfür: jede(r) von uns!

FROHE WEIHNACHTEN !!!!

Parallelaktivitäten

o TR07

- Wartung von 440 V-Batterien *maint. of Bat* — H. Achter
- Funktionstests von MRE's *Functional tests on MRE on test bench magnet control* — H. Schmid, H. Zinselmeyer

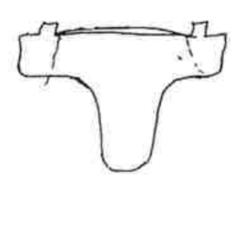
o Sonderfahrzeuge *Special vehicles*

- Instandsetzung Wartungsfahrzeug I (Mittwoch, 16.12. bis Freitag, 18.12.92) *Wed – Fri* *maintenance/repair Two maintenance veh. for Guideway* — Fa. Wester, IABG, Herr Thiele
- Instandsetzung Wartungsfahrzeug II — Fa. Messmann, IABG, HH. Schmitz, Thiele

o Fahrweg *Guideway*

- Fortsetzung der Überprüfung der Statorbefestigungen des Fahrwegbereiches 2. BA *Cont. inspec of stator fasteners on Southern loop*
- *1st Environm. test on sample parts on redundant systems for steel & concrete in Southern loop.* Erste Umwelttests von Musterteilen, der für Stahl und Beton Süd konzipierten Redundanzbefestigungen (ab Dienstag, 15.12.) *Start. Tues →* — H. Dr. Wedemann
- Probemontage von Redundanzbefest. im Stahl und Beton Süd *Provisional mounting of redundant fasteners for Steel & Concrete Beams* — H. Pieper, Fa. Funke
- Austausch von 3 Statorpaketen incl. deren Befestigungselemente aus dem Stahlfahrweg 1. BA *exchange of 3 stator packs including fastening elements in Steel Guideway northern loop.* — H. Kuper, QS, H. Auth
- Fortsetzung der Arbeiten: Reinigung der Entwässerungsrinnen im Beton 1. BA *Continuation of the following activities* *clean drains* — H. Kuper
- Fortsetzung des Aufbaues der Meßeinrichtung an Träger 558 *Cont. of installing the measurement for Pillar 558 prototype* — IABG Lichtenau, H. Dr. Korb

Gosse gutter in German



TERMINE
Randbemerkungen
Erledigungsvermerke

Control of Stator Pack ck securement

for damage table Counting each pair of limit to

- Kontrolle der Statorbefestigungen entspr. der Schädigungstabelle im Bereich der Kanaltrasse und der W 2 — H. Kuper, QS, H. Auth
- Korrektur einiger Statoren des Trägers 311 nach Angaben — HH. Thiele, Steinmetz, Auth, QS
- Weiterführende Funktionsmessungen an einzelnen Stellgliedern der Weiche 3 — HH. Brameyer, Deymann

Ausblick auf KW 53:

Kein Versuchsbetrieb ! NO testing

KW 01/92

mon - wed

Montag, 04.01.93 bis Mittwoch, 06.01.93 (Heilige Dreikönige):

Kein Versuchsbetrieb ! no testing (Mon tue & wed)

Donnerstag, 07.01.92 und Freitag, 08.01.93 bis 14.00 Uhr:

o TR07-Hallenbetrieb (Fahrzeug ist aufgerüstet) inhouse

- Wiederanbau der großen Seitenverkleidung. Re install access pannel — Fahrzeug-mannschaft

o BLT II

- Tests im Simulationsbetrieb (Fehlersuche am FUE-Rechner) — SB, H. Schölleke
- Reparatur der FSI-Meßeinrichtung — SB, NN

gez. Decker

APPENDIX B

Text Figures

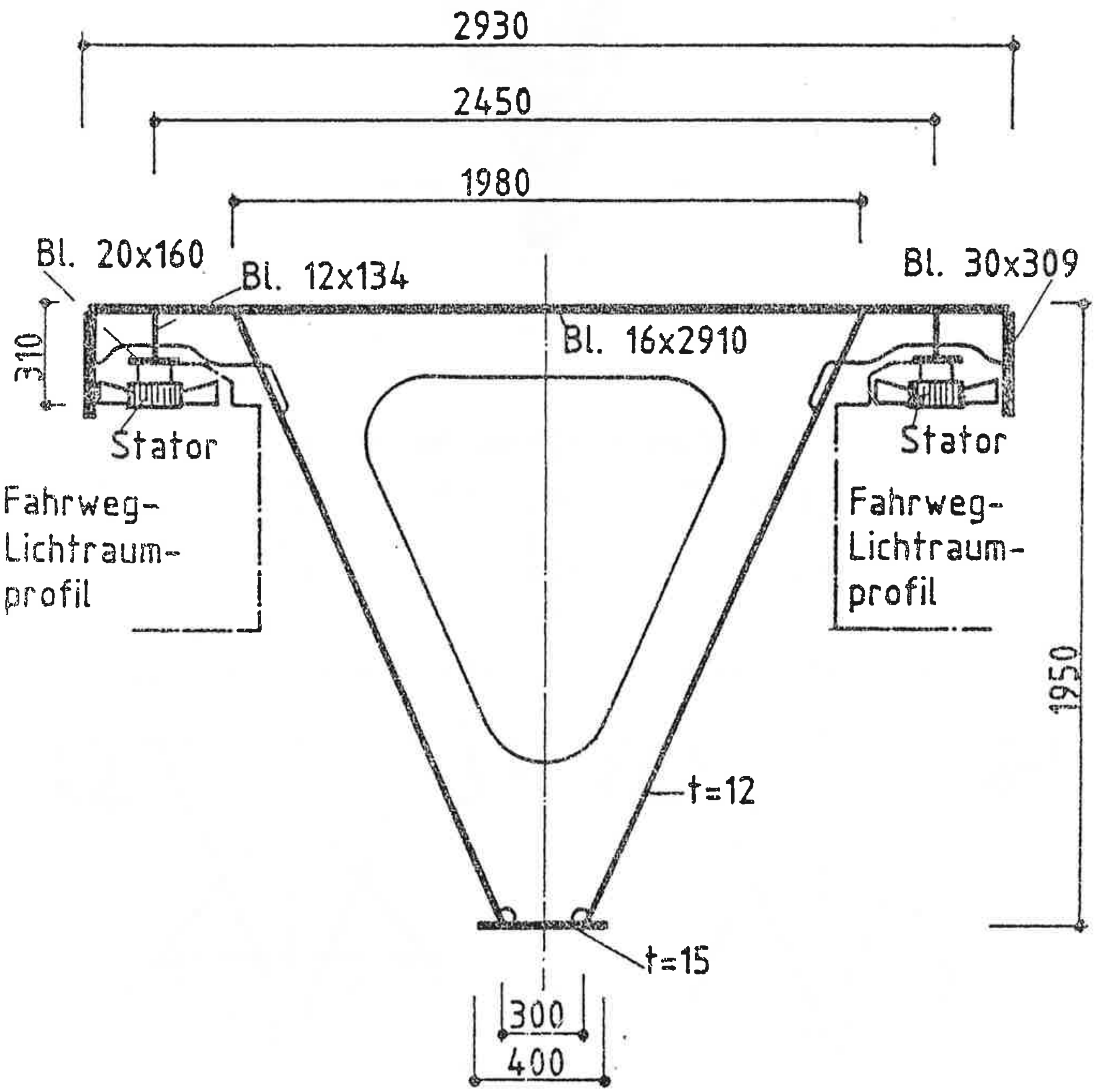


Figure 1. Cross-Section of Prototype Steel Beam (Florida)

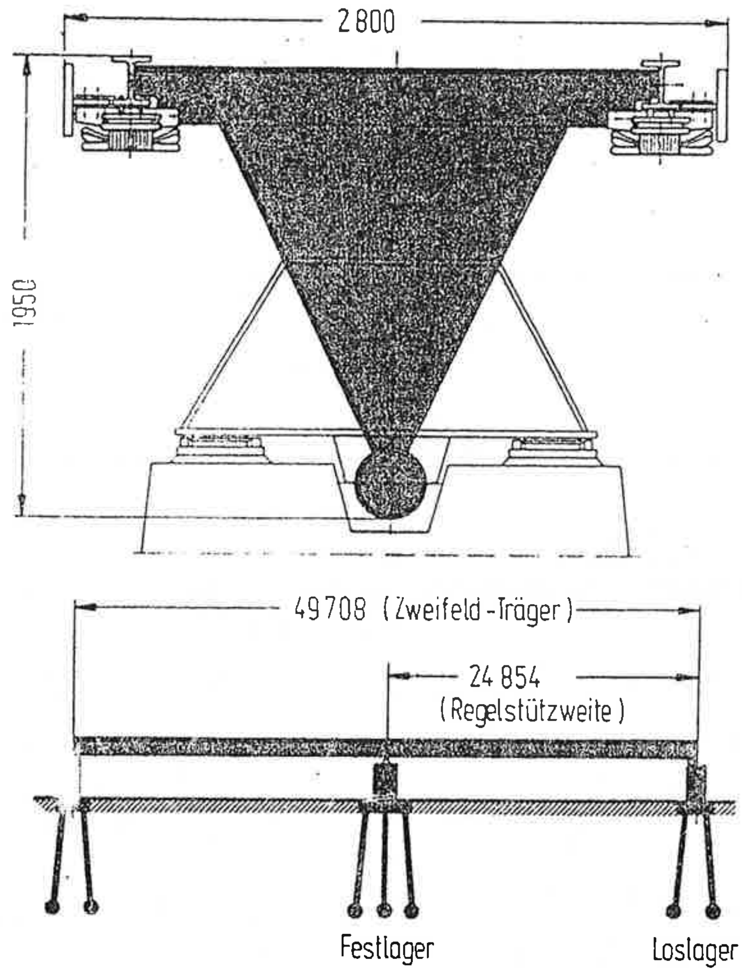
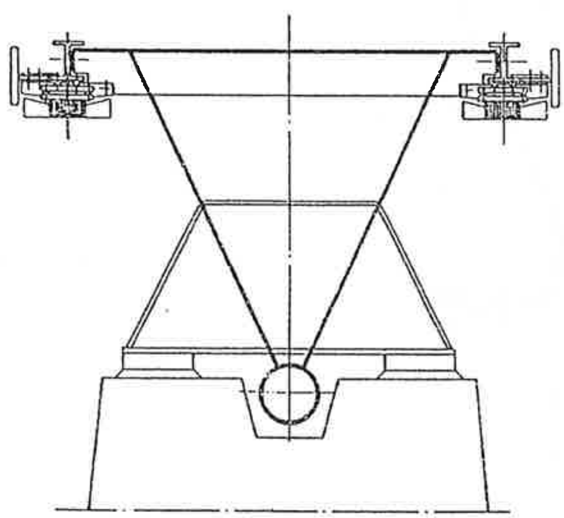
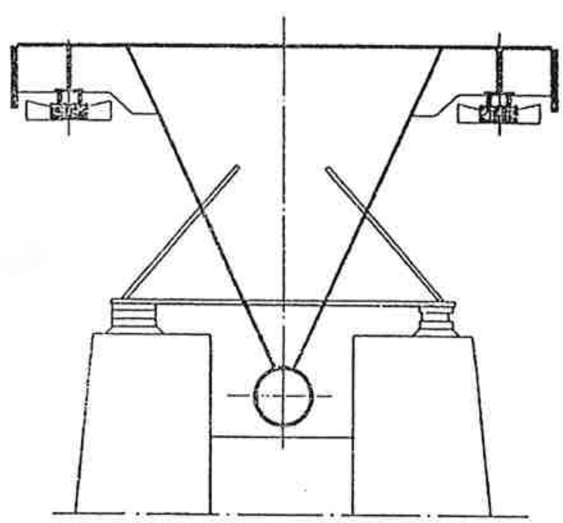


Figure 2. Cross-Section of Double-Span Steel Beam (Northern Loop)



1. Bauabschnitt TVE



TVE - Südschleife

Figure 3. Cross-Sections of the Steel Beams on the Northern and Southern Loops

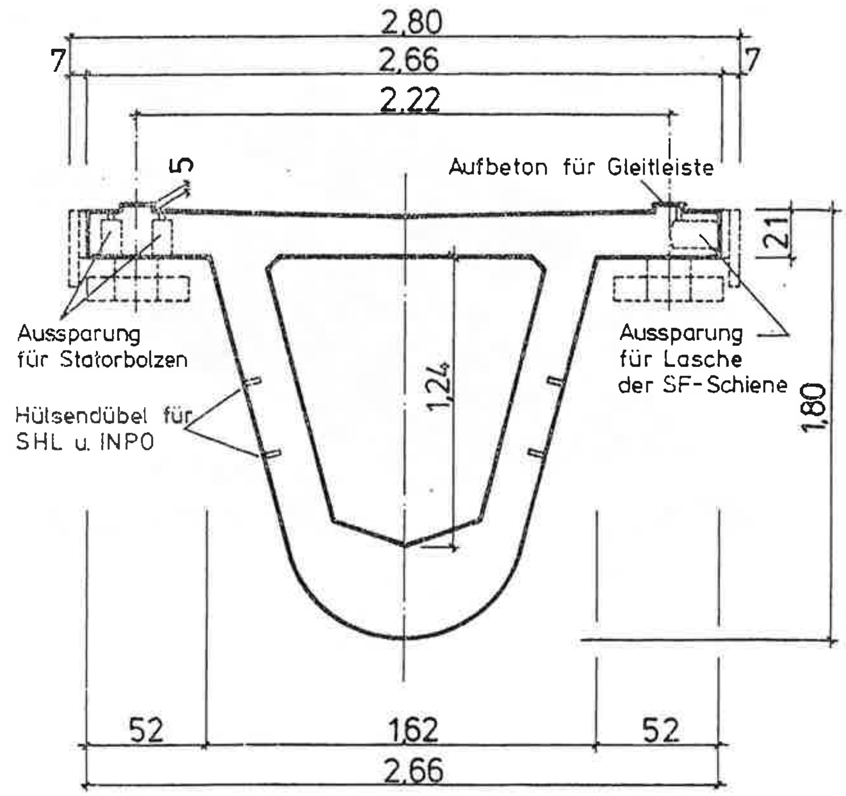


Figure 4. Cross-Section of the Concrete Guideway

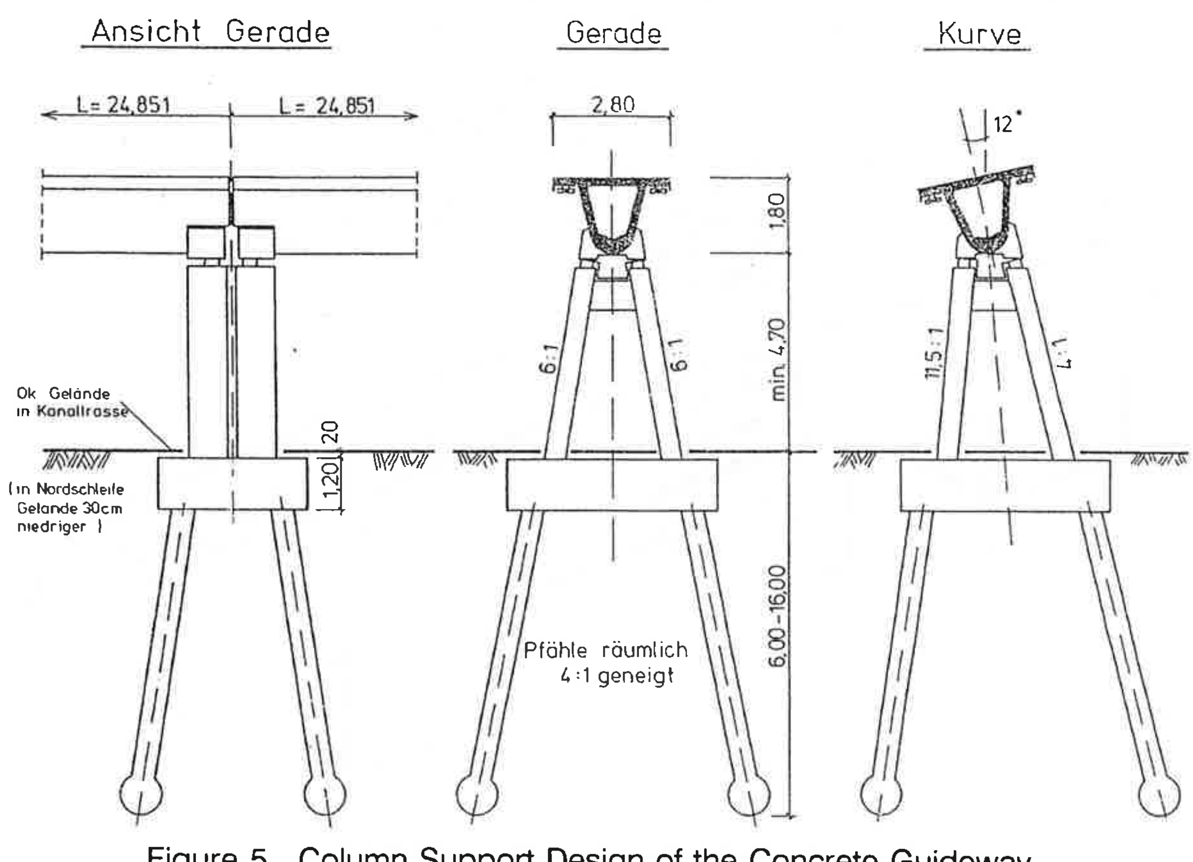
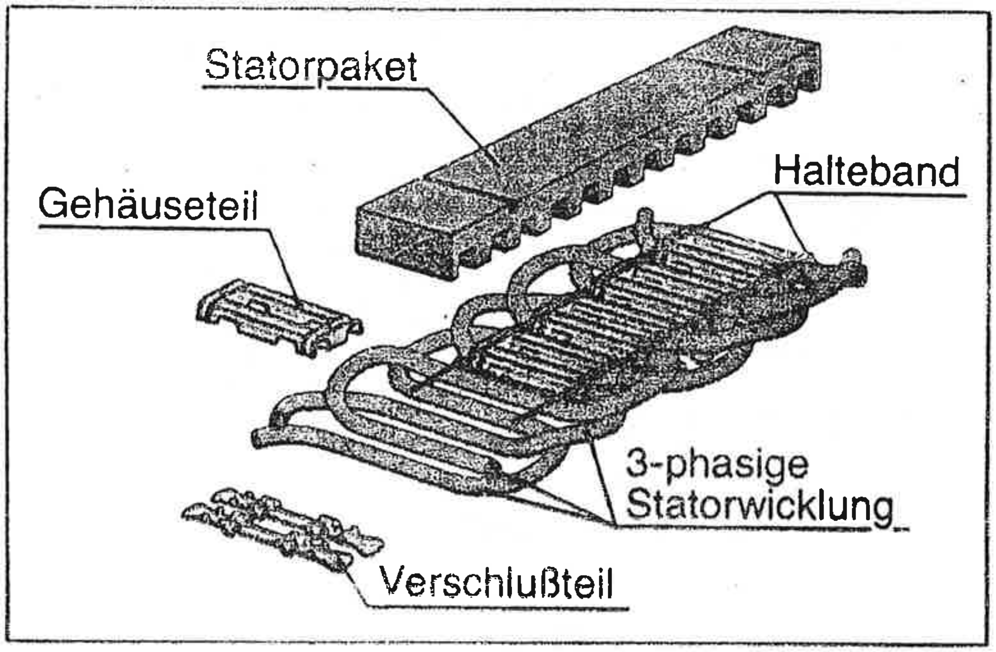


Figure 5. Column Support Design of the Concrete Guideway



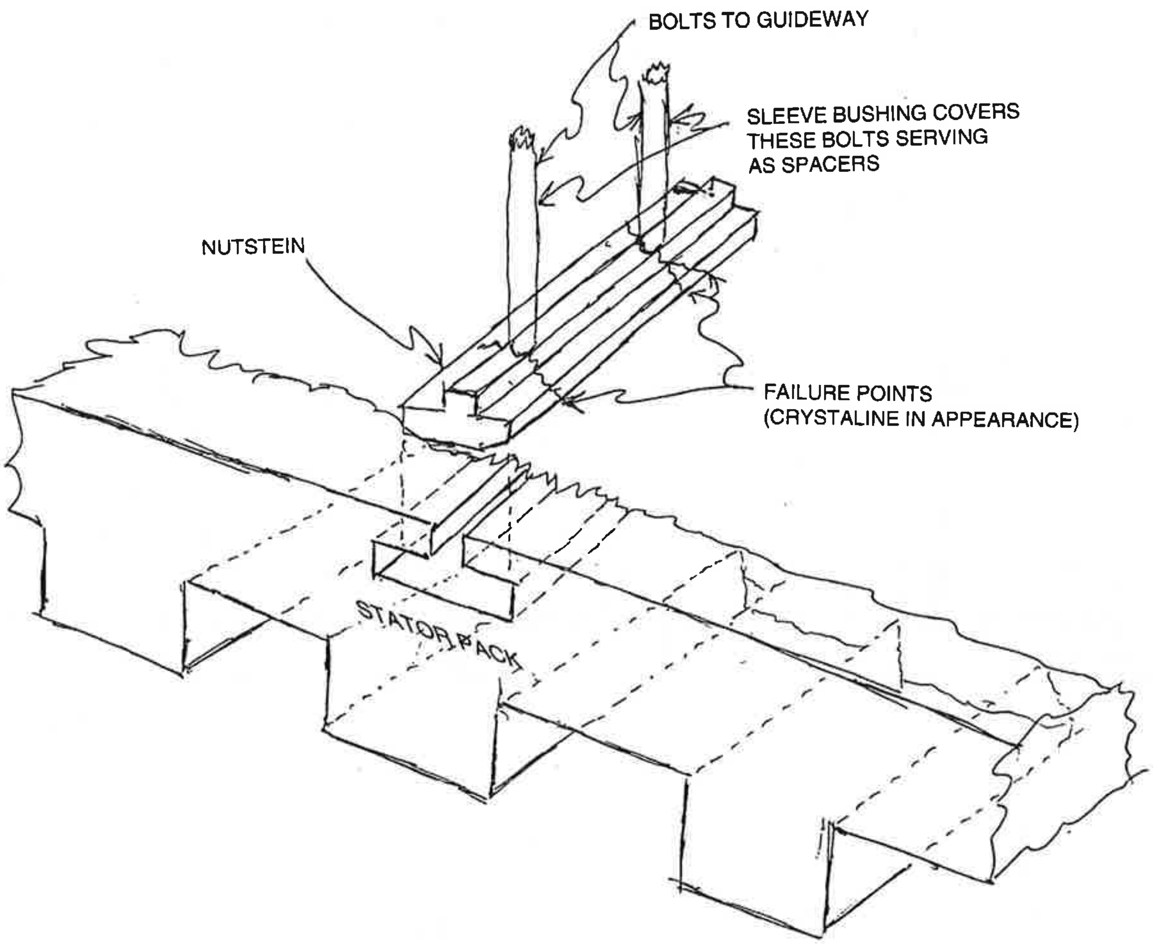


Figure 6. Stator Pack and Nutstein Failure

Figure 7. One-Half Existing TR07 Levitation Magnet Configuration

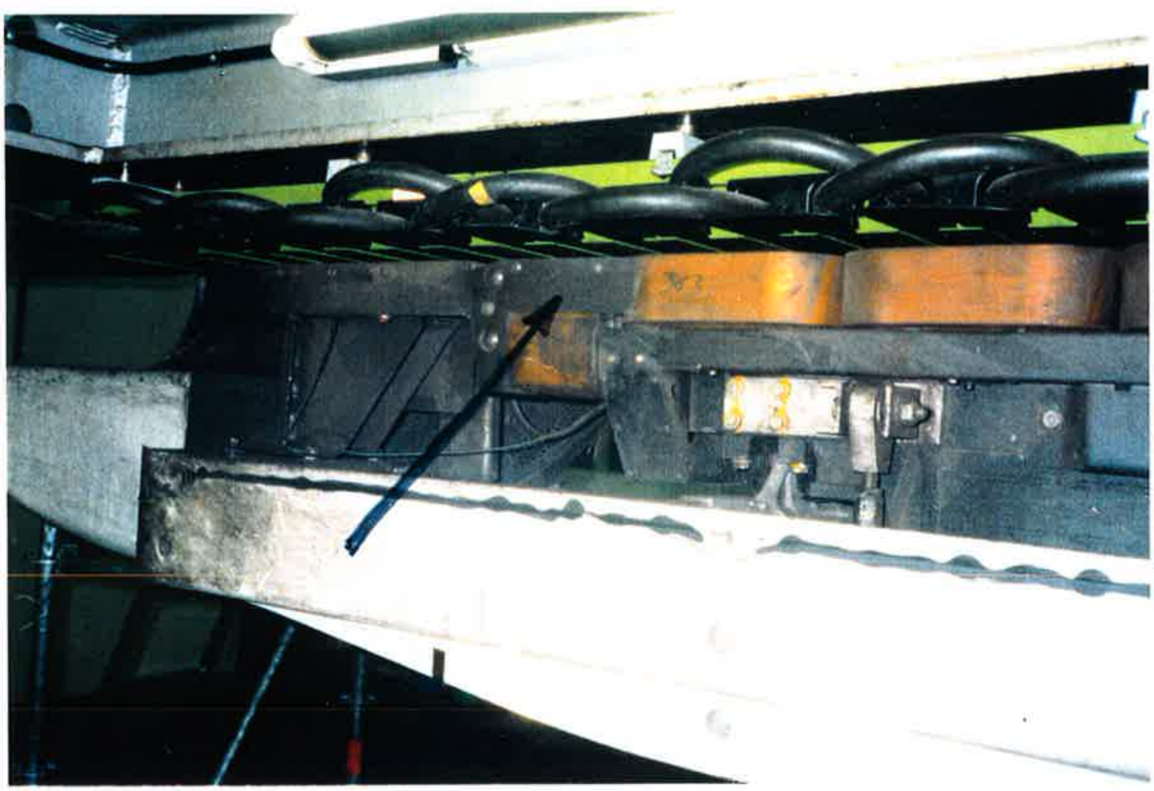


Figure 8. Existing TR07 Gap Sensor

Figure 9. Location of New Dual Gap Sensor

Figure 10. MRE Functional Testing Setup

Figure 11.
Calibration Arrangement
for Gap Sensors

Figure 12. Example of Surface Condition of Steel Guideway in Northern Loop

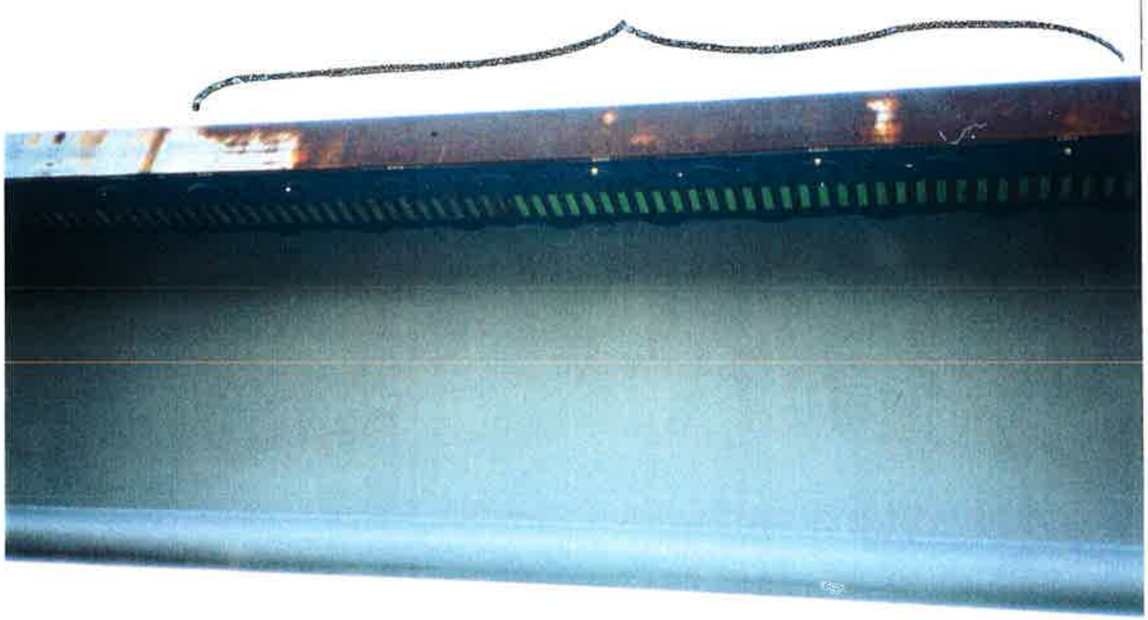
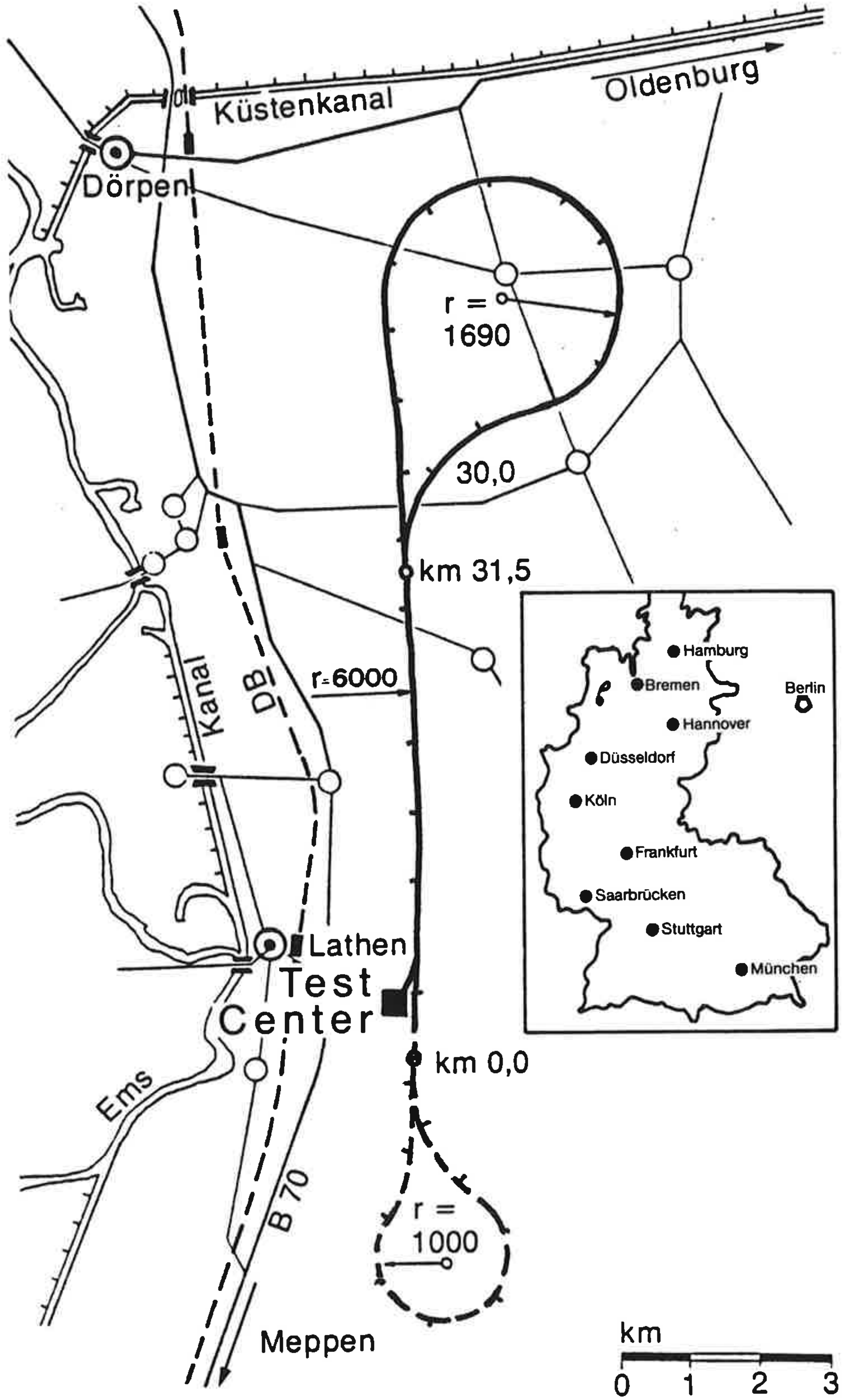


Figure 13. C-Channel Clamp Proposed To Retain Adjacent Stator Packs

Figure 14. TR07 Skid Assembly

APPENDIX C

Supplemental Figures



TVE Test Facility Location

Switch 1

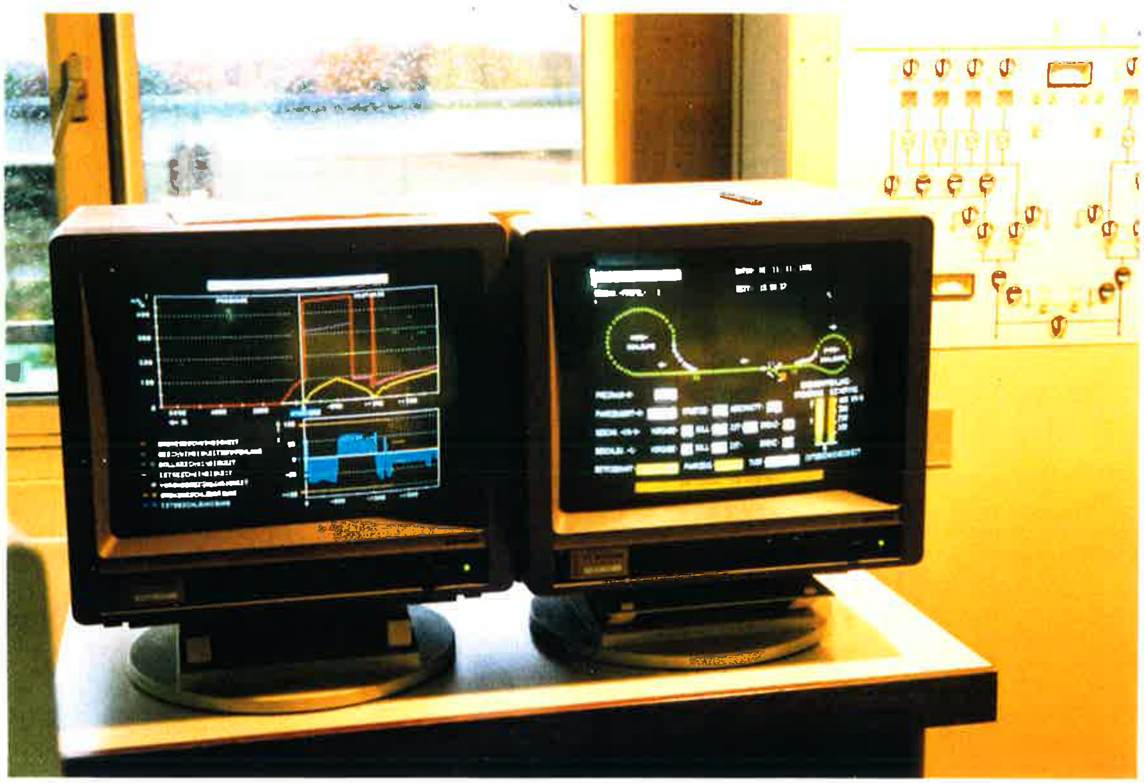
Switch 2

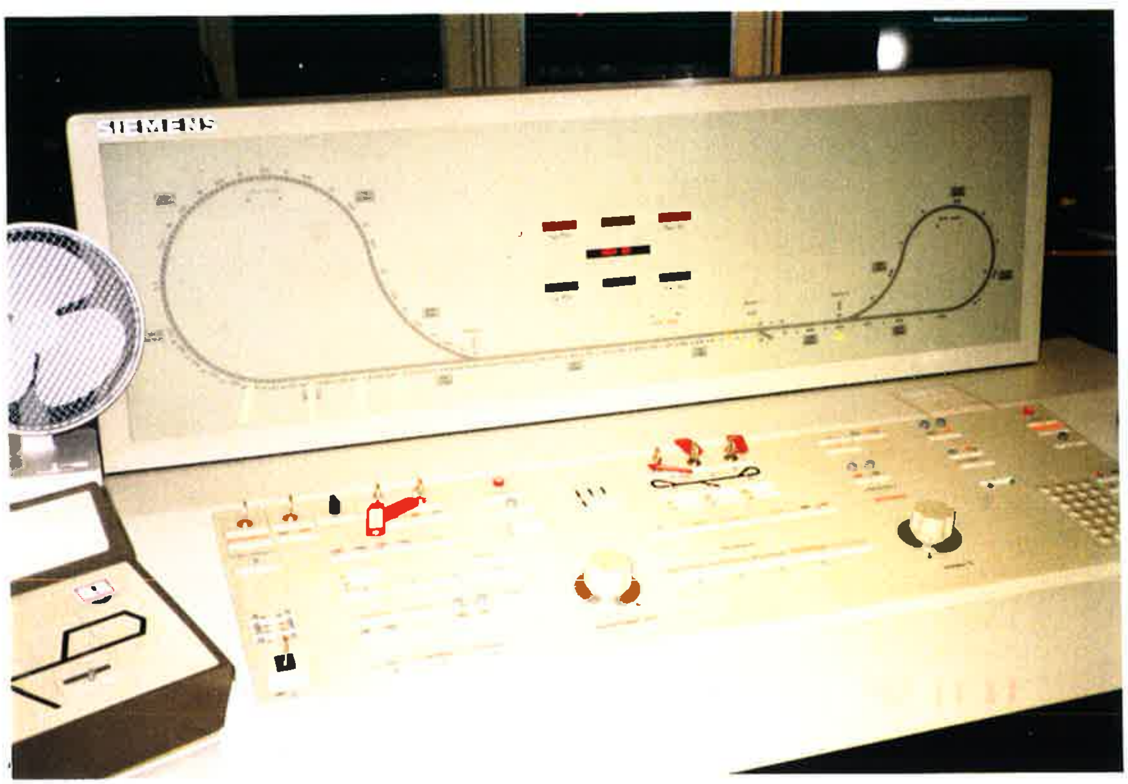
Switch 3 - Looking North

Switch 3 - Looking South

Switch 1, Lined for Maintenance Facility

Switch 3 Locking Mechanism





Control Room Displays

TR07 Vehicle at Passenger-Loading Station

Power Pickup at Passenger-Loading Station

Access/Evacuation
Walkway (at Switch 3)

Evacuation Walkway Egress Point,
(On Southern Loop)

50-m Steel Test Beam

Noise Wall (on Northern Loop)

TR06 Vehicle, Outside of Maintenance Facility

Fire Rescue Truck at the Maintenance Facility

TR07 Operator Cab

Interior of TR07 Passenger Section

View of Switch 3 from the Special Utility Vehicle

Wartungsfahrzeug I Maintenance Vehicle

APPENDIX D

The Optimization of the Statorpack Attachment for the Guideway of the Maglev

THE OPTIMIZATION OF THE STATORPACK ATTACHEMENT FOR THE GUIDEWAY OF THE MAGLEV

K. F. Rother, Thyssen Henschel

ABSTRACT

Since beginning of development in 1974, German long–stator MagLev technology has reached remarkable milestones and taken the lead worldwide. The MagLev transportation system TRANSRAPID, supported by the German Federal Ministry of Research and Technology has been developed under the responsibility and leadership of THYSSEN HENSCHEL to improve guided transport with respect to speed, economy, environmental effect, riding comfort and safety. Through intensified test runs on the Transrapid Test Facilities (TVE) in Emsland (Germany) 100,000 km milage has been reached with this new technology.

An important part of the long–stator drive is the statorpack including the three–phase cable winding attached to the guideway beam. The statorpack consists of a stack of sheets glued together. Its attachments transfer the support and propulsing forces of the vehicle and therefore count as important and highly stressed components.

To reduce cost for the guideway and safely cope with the transferred loads in addition to a high endurance limit for the statorpack attachment, numerous finite element calculations, optimization and testing for qualification have been done. With the aid of codes and standards for the design of an eccentric loaded and eccentric braced single bolt connection, which are already widely accepted in industry, as well as the implementation of an effective computer–aided engineering concept, we applied an efficient strategy for its development and optimization.

1. INTRODUCTION

Since starting operation of the first section of the Transrapid Test Facilities (TVE, see fig.7) in 1984, the German high speed MagLev transportation system TRANSRAPID has reached essential milestones of development. Also, the world record for manned high speed MagLev vehicles of 435 kmph was reached in 1989. This speed was restricted only by the length of the 32 km test track. In 1990, speeds above 400 kmph could be repeated any time with the TRANSRAPID 07 which is designed for speeds up to 500 kmph (see fig.8).

In connection with the test rides in 1990, a large number of measurements of the loading of vehicle and guideway were taken as a necessary basis for development and manufacture of the prototype revenue service guideway. The measurements widely agree with the theoretical loads developed for the design of the vehicle TRANSRAPID 07.

The guideway beams of the Transrapid Test Facilities are made of steel or concrete. From 1989 until 1990, in connection with the further development of the steel guideway, the prototype of an application oriented beam was developed, manufactured and integrated in the Transrapid Test Facilities. For this type of guideway, which is a two span beam, the statorpack attachment of the long–stator drive was also optimized using the experience of all the preceding measurements on the test track.

Controlled electromagnets and a synchronous, ferrous long–stator drive ensure the contactless support, guidance and propulsion technique of the TRANSRAPID. The stator of the linear drive consists of approximately one meter long laminated statorpacks with the three–phase cable winding attached along the track (see fig.9, 10). The statorpacks also serve as the reactive part of the support magnets.

Because of the transmission of driving forces on the vehicle as well as the support forces on the guideway, the statorpack attachments have to be treated as highly stressed parts in the primary flux of force. Due to the continuous support magnets along the whole vehicle, the TRANSRAPID is "elastically supported".

This and the lack of concentrated loads (for example due to wheels) on the long–stator makes a consequent lightweight construction possible. Of course not only does the components of the guideway but also the design of the whole vehicle takes advantage of this.

The strategy, used for the dimensioning and design of the statorpack attachment by THYSSEN HENSCHEL is described in the following.

2. PROBLEM TASK AND MECHANICAL STRUCTURE

The statorpack attachments for the first and second section of the test track have been designed on basis of a safe–life concept and a definite durability. Therefore high demands on quality for all parts of the attachments in addition to periodical inspections had to be required.

Until now, no bolt has failed under service conditions, however the decision for an application oriented guideway has been made for a fail–safe concept with almost no requirements on the bolt joint.

The principal concept of the new statorpack attachment is the safe suspension of the statorpack through a bolt connection (primary attachment) combined with an additional secundary suspension providing full redundancy (see fig.11).

Full redundancy means that if more than one bolt connection fails, this defect is revealed, gets recognized and the statorpack is still attached to the guideway through another (secundary) suspension. This fail–safe concept offers a number of advantages for a revenue system:

- if a primary connection fails service does not have to be stopped. Repair can be done in a shut down period
- through an on–line measuring method built in the vehicle, examination of the guideway is executed with every passage
- safety factors for the design and quality assurance can be reduced. 100% safety against failure in connection with a complete track and definite endurance limit is not necessery anymore. This has major influence on the cost of the guideway
- number and kind of inspections of the guideway, according to building regulations, can be reduced to a minimum.

The concept of a safe redundancy is based on the fact that failure of the primary suspension is recognized in a short term so the damage can be repaired as well as the general suspension is guaranteed through the secundary attachment until repair is carried out. That means, if failure occurs, the statorpack is lowered for a definite amount by external forces until the secundary suspension operates. Fault detection follows with recognition of a discontinuity at the lowered statorpack by the on–line guideway measurement system installed in the vehicle. The redundant statorpack attachment, therefore, also prevents contact between the support magnets of the vehicle and the lowered statorpack.

The statorpack attachment of the prototype beam is an optimum design for the bolting technique and holding of the statorpack during the fully automatic equiping of the beam (see fig.11).

There are two bars bonded into the stacked statorpack (see fig.12). The force flux from the statorpack into these bars occurs through form–locking and self–substance. The bars are fixed to the guideway with four bolt connections tightened to yield. The secundary suspension is realized with a pin which is connected to the bars at the statorpack and which fits with clearance into a hole at the guideway beam. This clearance ensures the safe revealing of the failure of multiple bolts and guarantees that the secundary suspension is not stressed under nominal conditions.

3. DIMENSIONING THE STATORPACK ATTACHMENT

In the case of the statorpack attachment, numerous structural analyses have been done to minimize the extremely time– and cost–consuming experimental qualification tests. Global and local investigations, mainly supported by finite element analysis, have been done to study the structural behavior and derive reasonable steps for design changes.

Main problems have been the inhomogenious material properties of the laminated statorpack.

For the dimensioning, experimental testing could be reduced on just the examination of the stiffness of the statorpack.

Since the principal concept of the statorpack attachment has already been fixed based on the fully automated handling and mounting technique for the guideway beam, the structural analysis could be done only in view of design optimization.

In 1990, application oriented endurance testing of vehicle and guideway had to be continued. For that purpose, the essential milestone of a 100,000 km milage had to be reached on the Transrapid Test Facilities. The behavior of the prototype beam should be investigated experimentally during these intensive test rides. Therefore, a rigid schedule for development, qualification, manufacture and integration had to be observed.

Focal points of the analysis were as follows:

- optimization of the cross sectional shape of the slots in the statorpack which are necessary to bond in the bars

- optimization of the bolt joints in connection with the design of the bolt and the flanges

- dimensioning of the bars and the parts of the secundary attachment of the statorpack.

In the following, the first two steps of analysis are described as an example.

3.1 DIMENSIONING OF THE BOLT CONNECTION

For the dimensioning of the bolt connection and the shape optimization of the slots in the statorpack, a procedure was applied involving the use of an already widely accepted code in industry. This code is the VDI 2230 from the German Society of Engineers which effectively treats the sizing of single bolt connections.

With the aid of VDI 2230, you can dimension an eccentric loaded and eccentric braced single bolt connection even under nonlinear behavior of the bracing.

For calculation you need the local external loads and moments applied to the connection. The derivation of the applied loads and moments was done with the aid of a finite element model of the complete statorpack including the attachments and loaded with the global external maximum force amplitudes which were measured on the Transrapid Test Facilities.

For the calculation of these local external loads acting on the bolt connection with the aid of the finite element method there are three major ways which can be applied as necessary (see fig.1):

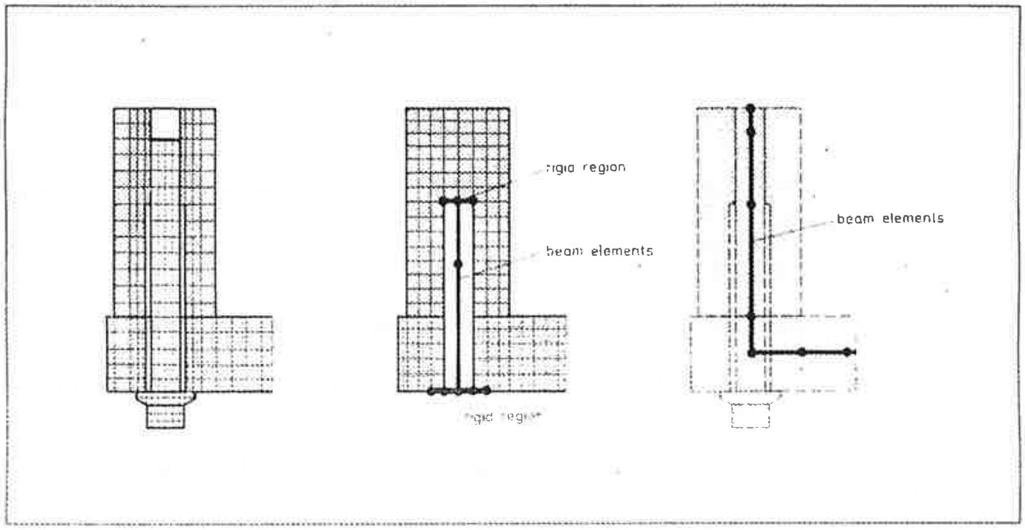


FIG.1 FINITE ELEMENT MODELS FOR BOLTED JOINTS

a) Complete model of the bolt connection meshed completely with solid elements.

Advantages:

- best method to consider all parameters of the bolt connection in the finite element model
- calculation of strains and stresses in the complete structure
- nonlinearities can be considered (plastification of material, gaping at the plane of separation)
- tightening of the bolt can be included by prestressing.

Disadvantages:

- very expensive model and less flexible. Therefore, not useful for optimization applications
- very large model which may include a lot of gap elements. Therefore, high solution times
- difficult postprocessing and judgement of the real stresses within the bolt (stress concentration).

b) Complete model of the flanges meshed with solid elements. The free parts of the bolt are modelled with beam elements. This method is mainly useful for bolts with a large ratio of free length and major diameter because the influence of head and thread engagement is not considered in this model.

Advantages:

- cutting forces and moments acting on the bolt are easy to analyse during postprocessing. Then, simple judgement of the complete strains and stresses in the bolt can easily be done with the aid for example of VDI 2230 or fatigue curves, if available
- either material nonlinearities of the bolt (elastic–plastic behavior) or nonlinearities in the plane of separation (gaping) may be included
- the clamping forces of the bolt can be modelled

- the essential stresses in the braced flanges can be analysed.

Disadvantages:

- this type of modelling is very similar to method a) and, therefore, also less flexible for optimization
- bad results for very short bolts
- time-consuming.

c) Modelling of the complete connection with simple beam elements considering the cross section of bolt and flange together in one element. This model is only useful for connections with relatively simple cross sectional shape. The exact analysis of the connection regarding stresses, displacements and strains has to be done by means of an additional calculation with the aid of codes and standards (VDI 2230 for example).

Advantages:

- very easy model
- very powerful for optimization applications.

Disadvantages:

- can only be used for connections with a very simple cross sectional shape
- the effects of clamping forces of the bolt can only be considered in the succeeding calculations
- not useful for connections where large gaping effects and, therefore, rearrangement of the cutting forces and moments occur
- only the external cutting forces and moments acting on the complete connection are derived, but not stress or strains of the different parts (flanges or the bolt itself).

For the analysis of bolt connections mainly methods b) and c) have been used by THYSSEN HENSCHEL. Since method c) is a very simple and reasonable technique, its application will be discussed in this paper on the example of the statorpack attachment. In this case, the method is very useful because of the simple shapes of the parts. To avoid corrosion problems, gaping should not occur. According to this boundary condition, nonlinearities need not to be considered.

It should be mentioned that the complete dimensioning of a bolt even with very large and detailed finite element structures is not recommended. The wealth of know-how and experience for the design of bolts, especially the very important details in the fields of material and manufacture, insure a bolt design with a very high quality. The bolt is a machine element for which most research has been done in the past. The complexity of the mechanical behavior of the complete connection as well as the material or manufacturing features to maximize fatigue strength need the conscientious application of all experience available.

3.1.1 LOADING OF THE STRUCTURE

The dynamic loading of the statorpack due to driving and support forces is acting in a frequency spectrum of about up to 600 Hz in the complete velocity range of the vehicle of up to 500 kmph. This frequency range is dependent upon the pole distance of the support magnets.

Considering all service conditions of the vehicle, the maximum amplitudes of the external support forces are about 34 kN and the driving forces approximately 1.2 kN per statorpack.

Numerous measurements at the Transrapid Test Facilities are the source for the loads. The basis for the design of the new statorpack attachment is a statistical evaluation of the maximum amplitudes of the forces measured. The complete range of velocities available for the tracing of the test track is covered by this analysis of the extreme values.

3.1.2 FINITE ELEMENT MODEL TO EVALUATE THE CUTTING FORCES AND MOMENTS

The statorpack is a beam clamped on both ends. The resulting compulsive forces due to external loading is dependent on the stiffness of the attachments including parts of the guideway.

To get the cutting power necessary for the optimization of the bolt connection and the shape of the slots in the stack of sheets, a finite element model was used (see fig.2).

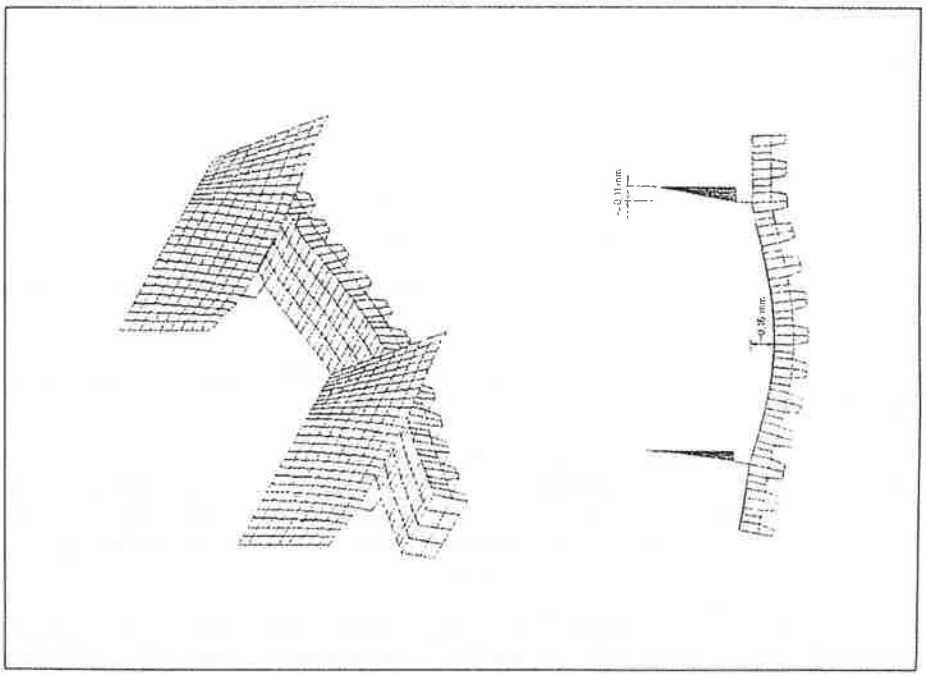


FIG.2 FINITE ELEMENT MODEL OF THE STATORPACK INCLUDING THE ATTACHMENTS. DEFORMED SHAPE UNDER LOADING.

For this model, the orthotropic material properties of the stack of sheets were considered. Since it is difficult to derive the material properties easily, experimental measuring of the essential stiffness values for the complete statorpack has been carried out. Using a bending and a torsion test with the original statorpack, the stiffnesses were evaluated and applied to the finite element model.

The bars bonded into the laminated statorpack as well as the components of the complete bolt connection including some parts of the guideway have been modelled with beam elements.

Some cross-plates of the guideway beam, necessary for representing additional clamping stiffnesses, have also been considered with shell elements.

Attention has to be paid only for the correct attachment of the torsional degrees of freedom of beams to the solid elements of the statorpack. Use of constraint equations takes care of this in a simple manner.

Using the loading described before, the cutting forces and moments were evaluated at the end nodes of the lateral bars. The maximum loads of the four screw connections have been used for the design of the attachment described by the following.

Because of the necessity of multiple iterations for the optimization of the bolt attachment, some calculations with the finite element model had to be done. Here, the power of the method has shown its advantages. Since the size of the stack of sheets had to be the same for every iteration, lots of versions could be generated by simply changing some real constants of the beam or the shell elements. Thus, time for the complete analysis could be reduced to a minimum.

3.1.3 APPLICATION OF THE STANDARD VDI 2230

The standard VDI 2230 of the German Society of Engineers is used for the systematic evaluation of a single bolt connection which is highly tightened. Revised and published in July 1986, this standard is a widely accepted basis for the design of dynamically loaded bolt connections. The following list describes the input data to evaluate the mechanical behavior and especially the stresses and the clamping conditions with this standard:

- strength category of the bolt
- (partial) reduction of the clamping force in the plane of separation due to external loading
- reduction of the clamping load due to setting in the plane(s) of separation
- spreading of the clamping force due to the method used for tightening and the deviation of friction coefficients
- fatigue strength due to alternating loads
- allowable compressive stresses of parts of the clamped flanges due to pressure distribution under the head and/or the nut.

As mentioned before, this standard allows consideration of nonlinear effects of the clamping conditions due to gaping in the plane of separation.

To design these dynamically loaded bolt connections, this is the only accepted standard available for Germany.

A complete and exact description of the geometric and elastic properties of the flanges and the bolt, friction coefficients, shape of the thread, loading and the application of power and so on represents the input data. To master the, especially for the nonlinear case, numerous formulas, a catalogue of the formulas to be used is supplied along with the standard. Because of the necessity of multiple iterations for the optimization, these formulas were programmed with a computer. With this automation it was possible to evaluate every modification very fast and reliably.

In case of eccentric clamping and/or eccentric loading, bending stresses occur in addition to the tensile stresses due to the forces superimposed. The stresses in the bolt rise linearly until gaping occurs. Whereas, after the initial gaping in the plane of separation, the additional forces in the bolt rise progressively until the complete opening of the connection (see fig.3). In the extreme case, the bolt joint degenerates to a hinge. The most important advantage of a highly tightened bolt connection is the reduction of dynamic stresses. This advantage vanishes with increasing effects of gaping. For that reason gaping should be avoided.

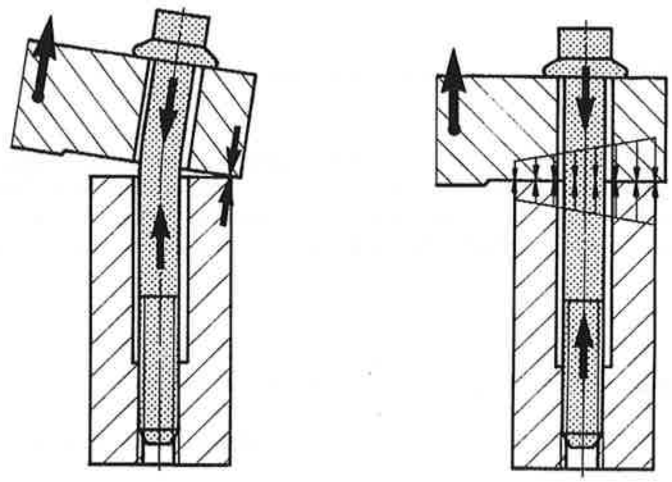


FIG.3 ECCENTRIC LOADED SCREW JOINT. SITUATION BEFORE INITIAL GAPING OCCURS AND WITH (THEORETICAL) COMPLETE GAPING (HINGE)

With this method, in addition to the safety concept, the attachment of the statorpack could reach an optimum design. In co–operation with the bolt industry, we were able to specify a concept and a layout for a detailed design, use of materials and surface protection as well as manufacture and quality assurance. Some major goals were the maximization of:

- fatigue strength
- fatigue behavior in connection with corrosion
- ductility of the material
- safety against twist–off.

Not only a satisfying bolt joint could be designed with the strategy displayed, but also a realistic specification considering the requirements and possibilities of the bolt industry could be defined. All requirements have to be graded very high but they consider the state of the art available from the bolt industry as well as economic manufacture.

The specification is mainly oriented at the important codes and standards for the design, material and testing of bolts in the fields of mechanical as well as aerospace engineering.

3.2 OPTIMIZATION OF THE SLOT

A second example regarding the statorpack attachment of the prototype beam is the optimization of the slots in the stack of sheets. Within these slots the bars for the attachment of the statorpack are bonded in place. Similar to the optimization of the bolt joint, a very simple model was used. The results are accurate enough for optimization. With this example we want to show that even with the background of rising computer power a reasonable computer–aided engineering concept should be developed to investigate numerous variations and not primarily the fineness of the models.

Only through a flexible structural analysis which supports or even precedes the process of detailed design, significant improvement of quality in connection with less cost and time for development is possible.

In the future more than ever, a structural engineer mainly has to use his basic physical understanding along with analysis to get an optimum design. This way, even more than increasing accuracy, is the strategy of the future and necessary so that structural analysis are not become an end in itself.

Of course it is obvious and hopefully will never be doubted that this strategy can only be carried out by engineers, even if the software gets more and more comfortable.

The shape of the slot should be dovetailed with rounded corners and ending (see fig.4).

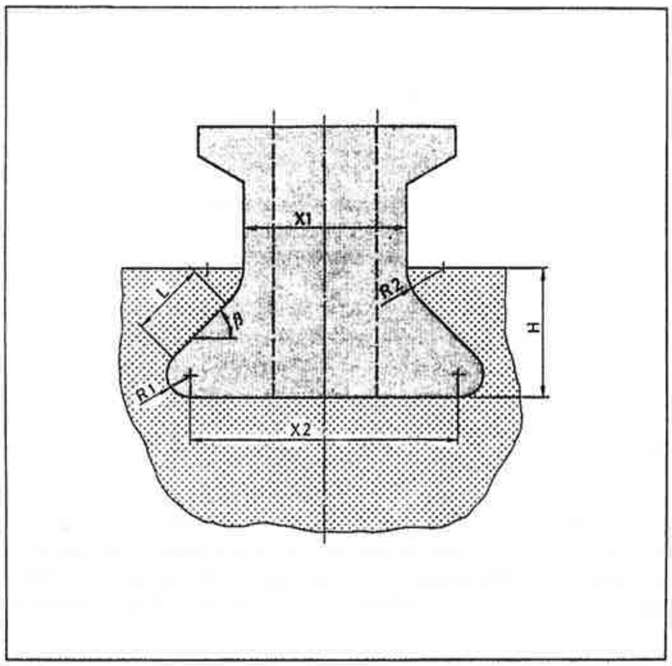


FIG.4 SHAPE OF THE SLOT IN THE STATORPACK INCLUDING THE BONDED BAR FOR THE ATTACHMENT AT THE GUIDEWAY BEAM

For optimization a two dimensional model with solid elements under plane stress conditions was used (see fig.5). For the layered type of construction of the statorpack this idealization is accurate enough.

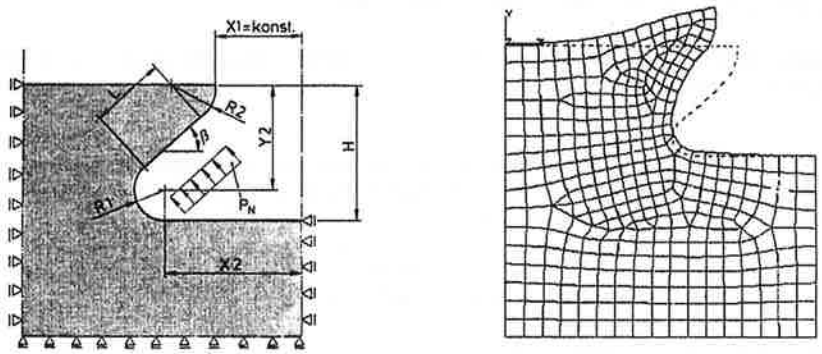


FIG.5 FINITE ELEMENT STRUCTURE AND DEFORMED SHAPE OF THE SLOT UNDER LOADING

The shape of the slot had to be optimized in order to minimize equivalent stresses, stress gradients, displacements and contact pressure and mainly the depth of the slot. A design should be developed which fulfills in an optimal manner the needs of the bar bonded into the statorpack.

The design variables are the radians R1, R2 and the slope angle beta. As constraints the angle beta should be greater than 43 degrees and the ending of the slot should be under 90 degrees to give optimal stiffness for the automatic stacking of the sheets. The maximum equivalent stress (v. Mises) had to be restricted to 57 N/mm2.

As an objective, the depth of the slot should be minimized to reduce the influence on magnetic flux in the statorpack.

The external loads should be applied to the straight line between the two radians as an uniformly distributed pressure. These loads are derived from the normal forces and torque calculated with the global finite element model described before. The pressure value changes with varying angle beta and length of the straight line. This aspect was easily implemented in the ANSYS model using the parametric language.

Only 14 iterations had to be made to reach the goal. The result can be seen as a displacement plot in fig.5. For the optimum design the outlet radius was maximized and the inner radius was minimized. The slope angle beta is calculated at the lower edge of this state variable. The variation of the two radians versus the iteration number is shown on fig.6. as an example.

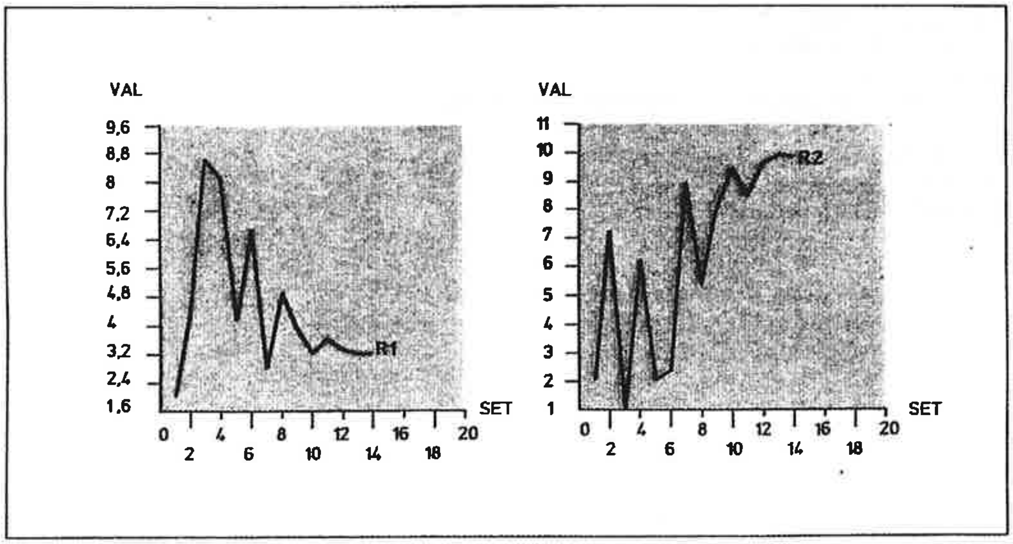


FIG.6 VARIATION OF RADIUS R1 AND R2 VERSUS THE NUMBER OF ITERATION

4. EXPERIMENTAL QUALIFICATION

Finally it should be mentioned that in connection with the development of the prototype beam, extensive testing has been made for the qualification of the beam and the statorpack attachment.

The qualification tests should give the experimental proof of fatigue strength of the statorpack suspension and the bolt including the application of power at the guideway beam. Bench tests to proof fatigue strength including corrosion testing on a 3 meter long test beam turned out completely positive.

In addition, the prototype beam was manufactured, equipped fully automatically with statorpacks and integrated in the test track. Measuring devices and strain gages were attached to get the loading and the deformation of the different parts under service conditions with the vehicle TRANSRAPID 07. During the extensive test runs the necessery data could be measured in a velocity range up to over 400 kmph. Finally, it was possible to reach all specified goals.

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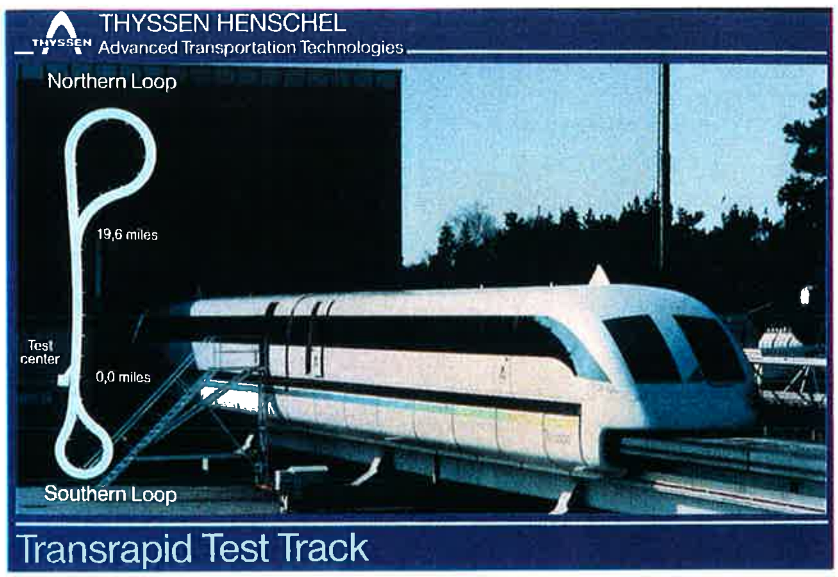

FIG.7 TRANSRAPID TEST FACILITIES, EMSLAND (GERMANY)

FIG.8 TRANSRAPID 07

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FIG.9 STATORPACK WITH THREE–PHASE CABLE WINDING

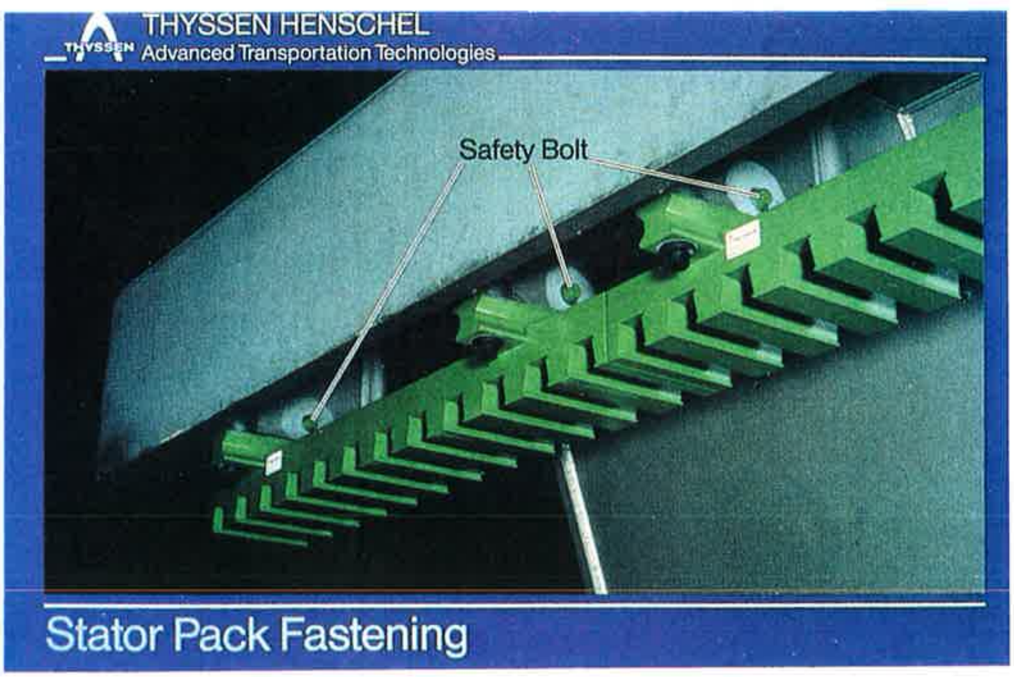

FIG.10 STATORPACK ATTACHED TO THE GUIDEWAY BEAM

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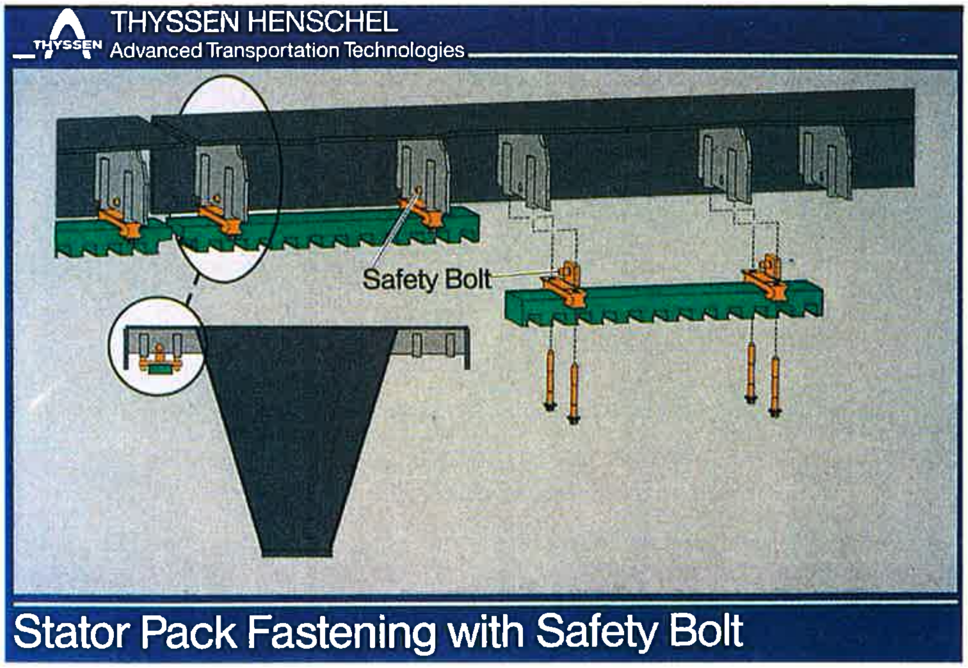

FIG.11 STATORPACK ATTACHMENT

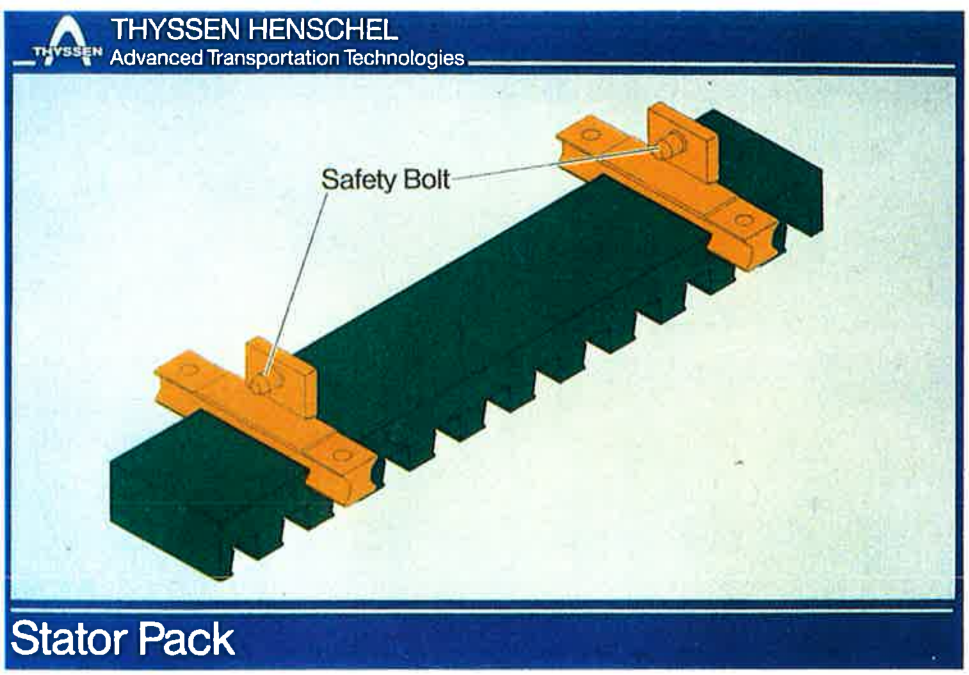

FIG.12 STATORPACK

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