簡易電化方式と電子連動

本日は、国鉄における最近の技術開発ということで、最近一部の線区で実用化された簡易電化方式（ Simplified overhead contact system ）と来年の実用化を目指して技術開発を進めている電子連動（ Computer－controlled interlocking system ）を中心として説明したい。

国鉄においては現在、主に３つの目的をもって技術開発を進めている。１つは輸送需要の開発、２番目はコストの低減、３番目は設備の信頼度向上及び環境保全である。

輸送需要の開発という面では、速度向上に関する研究開発を推進している。新幹線については、近い将来２６０㎞／h 運転を目指しており、最初の段階として、東北・上越新幹線において来春より２４０㎞／h 運転を行う予定である。また、未来の鉄道として超電導磁気浮上式鉄道（Superconducting magnetically levitated linear－electric－motor propelled system）即ちMAGLEVの開発を進めている。

コスト低減も重要な課題である。このために、車両の省エネルギー化、電化設備の簡素化等の研究が進められている。また、現在開発中の電子連動は、コストの低減とあわせて、機能の拡張と高信頼性の確保を目指したものである。

環境保全に関しては、新幹線の騒音対策等が進められている。最近の技術革新に対応し、より進んだ鉄道を目指して、この他にも、各種情報システムの開発と改良等多くの研究開発が進められている。

ここでは、こうしたテーマの中から、電化と信号に関係の深い２つのテーマについて御説明したい。冒頭にお話しした通り、１つは簡易電化方式であり、１つは電子連動である。

最初に簡易電化方式について概略を御紹介したい。

電車線路設備（ overhead contact system）は、電気車（ electric rolling stock ）に電気を供給するための設備であり、支持物（ supports）、き電線（ feeder wire ）、架線（ contact wire ）等から成立っている。その構造は、列車の運転条件や気象条件等様々の条件を総合的に勘案して決定される。現在国鉄においては、一層の高速運転への対応、信頼性の向上、建設コストの低減といったことを目標として、架線構造や部品の材質の改良など多くのテーマで研究開発を進めている。簡易電化方式は、建設コストの低減を目的として検討され、最近一部の線区で実用化された方式であり、その概要を紹介する。

現在国鉄の在来線では、架線構造として主にシンプルカテナリー（ Simple Catenary system ）方式が用いられているが、簡易電化方式では直接吊架式（ direct suspension system ）が用いられる。直接吊架式の構造を図１に示す。シンプルカテナリーに比べて大きな特徴は、吊架線（ messenger wire ）とハンガー（ hanger ）がないことである。当然工事費は節約できるわけだが、シンプルカテナリーに比べて支持点付近における架線のたわみが大きくな

ること及び架線の応力が大きくなることは避けられない。また、温度変化による架線の高さ及び架線のたわみへの影響も大きくなる。これらは集電特性を悪化させることとなる。この問題に対処するため、張力を大きくすること及び自動張力調整装置（automatic tension control system）により、温度変化による影響を軽減することが必要となる。張力については、大きいほど集電特性は良くなる。しかしながら架線の必要残存断面積は張力に比例して大きくなるので、張力が大きいほど耐用年数は短くなる。また支持物への影響も考慮する必要がある。

従って列車の運転条件や設備の経済性を考慮して最適な張力を設定する必要があるが、JNRでは、現在通常より30％大きい張力を用いている。また、最近電化を行った線区においては、支持点付近にハンガーを用いることにより、集電特性の改善を図っており、これを図2に示す。図1との違いは、吊りロッドの内側で更に架線を支持していることである。

この方法により、支持点付近の架線の重を改善し、集電特性の向上を図っている。なお集電特性については、架線やパンタグラフの軽量化によっても改善されることが、理論的、実験的に確かめられていることを付け加えておきたい。

簡易電化方式のもう一つの特徴は支持物の簡素化である。これは、通常の方式に比べて電車線路全体の重量が軽量化されるためである。通常の方式では、支持物としてPCコンクリート柱が使用されている。支持物の簡素化としては軽量コンクリート柱を用いる方法もあるが、ここではH型鋼柱（H－shape steel pole）を用いた工法の簡易化について簡単に紹介したい。

支持柱は一般に基礎に埋設して建植されるが、PCコンクリート柱を建植する場合は、柱全体を立てた形で基礎部分を施工しなければならない。H型鋼柱の特徴は途中でボルトにより接続できることである。この特徴を生かして、鋼柱下部のみを基礎に埋設する作業をまず行っておき、鋼柱本体はボルトによって既に基礎に埋設されている鋼柱下部と接続するという工法をとることが出来る。

こうした工法を採用することにより、支持物の材料費とともに工事費についても節減を図ることができる。

以上のような方式により、JNRは最近一部の線区で電化を実施した。その結果では、電車線路設備自体で約20％の工事費が節減されている。今後とも、線区の運転条件等を考慮しながら経済的な電化を行うための1つの有力な方式と考えている。

電車線路設備の具備すべき条件は、集電特性の良いこと、信頼性、保守性の高いこと、建設コストの安いこと等であるが、これらは様々な要素によって左右され、複雑な関係にある。特に集電特性や保守性については、車両とも密接な関係にある。集電特性が架線の張力や重量とともにパンタグラフの質量にも影響されることは先に述べたとおりである。架線とパンタグラフの摩耗も密接な関係がある。電車線路設備をいかなるものにするかは、車両まで含めた全体のシステムとして考えることが望ましく、技術開発の成果もとり入れながら、構造や材質、施工方法といったことを総合的に考える必要がある。

また、それぞれの線区の運転条件や保守性、経済性等を総合的に判断して最適なシステムが決定されることとなろう。ＪＮＲとしても、今後とも線区にあった最適の電化システムを検討するとともに、更に進んだ電化設備を目指して技術開発を推進しているところである。

簡易電化方式の話をこのくらいにして、次に電子連動について説明することとしたい。

御存知のように、連動システムとは、列車や車両の進路を安全かつ高い信頼性を持って構成するよう駅の信号やポイントを制御するシステムである。そのため、連動システムには、高い信頼性とフェールセーフ機能が要求される。

最初の段階では連動システムは機械、次の段階では電気機による連動システムが使われてきた。その後、論理部品として信号リレーを用いた継電連動装置が開発され、現在では、国鉄において連動化されている駅の８０％が継電連動装置によっている。

更に進んだ連動システムとして、磁気増幅機やパラメトロン等の無接点部品を用いた新システムが研究されたが、これらは経済的理由その他により、実用化に至らなかった。

然るにマイクロコンピューター等の集積回路の発展は目ざましいものがあり、また高信頼性システムとしてフォールト・トレランスに関する技術も確実に発展している。これらの技術的背景から、汎用電子部品を用いてフォールセーフ性と経済性を両立しうるシステムの見直しを得た。

このような条件の下で、国鉄は１９７７年よりマイクロコンピューターを用いた電子連動装置の開発にとりくみ、数次にわたる試行試験を経て実用システムの設計に着手した。

この電子連動システムは「Safety Microprocessor System for Interlocking Equipment」略してＳＭＩＬＥと呼ばれる。

ＳＭＩＬＥの開発にあたっては３つの目標が定められた。

第１は導入コストの低減である。汎用電子部品を用いることにより機器価格を低くする必要がある。また、ソフト及びハードの標準化により設計、製造、検査等を自動化し、トータルコストの低減を図る必要がある。

第２は多機能化である。これには、進路設定の自動化、操作性の改善、故障診断の容易さ、ＣＴＣシステムとの結合の容易さといったことが含まれる。

第３は安全性の保証である。システムは継電連動装置と同程度あるいはそれ以上のフェイルセーフ性と信頼性を備えねばならない。更に、フィールドの信号機器の監視のためのソフトウェア論理機能を付加することにより、全体としての安全性を高める必要がある。

次にシステムの基本的な設計について述べることとしたい。

列車制御の機能は区間毎に異るものであるが、連動の機能は、各駅に変わることなく必要である。従って、異った駅での異った機能に対応するため、マイクロプロセッサーを各機能ユニットに設けたマルチプロセッサーシステムが導入されている。

直接安全性と関る機能、即ち連動によりポイントや信号を制御するといった役割をもつマイクロプロセッサーも、ＳＭＩＬＥを構成するマイクロプロセッサー群に含まれる。このマイクロプ

ロセッサーは、高度のフェイルセーフ性と高度の信頼性というＳＭＩＬＥの最も重要な要素を要求されるものである。従って、フェイルセイフマイクロプロセッサー略してＦＳＭが新たに開発された。しかし、他の機能については、汎用マイクロプロセッサーが使われている。

このようなマルチプロセッサーシステムにより、フェイルセーフ機能と多機能性がいずれも効率よく実現されることとなった。

また、汎用プロセッサーの利用によりコスト節減が可能である。

ＳＭＩＬＥのハードウェアの核となるのはＦＳＭである。基本構成は冗長系とエラー検出回路である。冗長性は３重モジュラー冗長系を基本としており、エラー検出は多数決回路（ＭＶＲ）によっている。

１つのモジュールベエラーが起これば、データ照合によりエラーが検出されＭＶＲの出力が訂正される。この検出と訂正は、プロセッサーとメモリー間のデータ処理毎に行われる。更にＭＶＲ故障による二重誤りの防止のために、フェイルセーフ比較回路が設けられ、各モジュールと各ＭＶＲの誤りを完全に判別することとなっている。また出力部にはフェイルセーフ出力回路が採用され、特殊なフェイルセーフ素子によって多数決出力を行う仕組みとなっている。ある回路で誤りが検出されればその回路の論理入力がカットされ、システムでは自動的に二重系に移行する。その状態下で不一致が起これば、すべての制御出力は安全側に固定され、装置は停止する。

ところで、ＳＭＩＬＥはマルチプロセッサシステムであり、このようなシステムではプロセッサの結合が問題となる。ＳＭＩＬＥでは独立したプロセッサーをシステムバスで結合しており、これをＳＭＩＬＥバスシステムと呼んでいる。バスに結合されるプロセッサーは標準化されたシートに装てんされ、プログラムを予めＲＯＭに書き込まれている。各プロセッサーの機能はＲＯＭの差しかえだけで容易に変更できる。故障診断は各プロセッサー間の相互診断によっており、ＦＳＭの故障マトリックスによって診断される。

ソフトウェアは標準機能とオプション機能、制御機能とデータ処理機能といったいくつかの機能に分割されている。基本的なプログラムは、連動、進路制御、スケジュール計画、運転管理、システム監視、制御卓である。連動のソフトウェアはＦＳＭに装てんされるＳＭＩＬＥの基本機能であり、いくつかの機能を有している。例えば、連動プロセスは継電連動の処理に基き、駅毎の特殊条件はデータとして持つようになっている。データの構造は配線を表わすように設計されている。

ＳＭＩＬＥは上記のような考え方で開発され、ＦＳＭを中心とした最初の実験システムが１９７９年に作られ、１９８１年より石打駅で試験が開始された。この試験の成功を受けて、ＳＭＩＬＥバスシステムを用いた第２段階の実験システムが１９８３年に試験され、システムの性能が確認された。

ＳＭＩＬＥの機能の第一は連動機能で、進路選別、信号機器制御、車両追跡のほか、線路閉鎖、信号使用停止、機器動作監視も含まれる。第二は制御卓とのインターフェースで、表示と入力受

付の機能である。第三はスケジュール計画で、列車進行の基本計画を記憶し、制御車からの入力によってそれを変更する。第四は運転管理であり、列車番号によって進路を自動設定する他か、進路の優先順位を判断し、列車番号の変更も行う。第五はシステム監視で、ＳＭＩＬＥ自体及び信号機器の動作シーケンスを記憶して保守毎にデータを提供する他か、故障の検出と診断を行う。更にオプション機能としてＣＴＣとの直接接続、列車情報出力、音声による進路制御等がある。

ＳＭＩＬＥの導入効果としては７つ考えられる。継電連動装置に比べて 1) 導入コストの安いこと、2) スペースが小さくてすむこと、3) 工期が短くてすむこと、4) 連動機能が簡単に変更できること、5) 自動進路設定できること、6) 安全性が高いこと、7) 保守性が高いことである。

I will speak today on the latest JNR (Japanese National Railways) technical developments, explaining mainly the simplified overhead contact system which recently began to be used practically on some JNR lines and the computer-controlled interlocking system which has been technically developed with a view to making it practical next year.

JNR is now proceeding with technical development for three major purposes. The first is the increasing of transport demand, the second is cost reduction and the third is the improvement of reliability of equipment and environmental protection.

By way of increasing transport demand, we are conducting research and development concerning speed-up. Regarding the Shinkansen, we are seeking to achieve operation at 260 km/h in the near future and, as the first step, we are scheduled to start operation at 240 km/h next year on the Tohoku and Joetsu Shinkansen Lines. Also, we are developing MAGLEV or superconducting magnetically levitated linear-electric-motor propelled system as a railway of the future.

Cost reduction is another important task. For this purpose, we are proceeding with research on such subjects as energy conservation for rolling stock and the simplification of electric equipment. The computer-controlled interlocking system which we are developing is aimed at cost reduction as well as expanding functions and assuring high reliability.

As for environmental protection, our present measures include noise countermeasures for the Shinkansen. Also, many other projects of research and development including the development or improvement of various information systems are being carried out to further advance railways in accordance with the latest technical renovations.

Here, I will explain two of these themes that are deeply concerned with electrification and signal engineering. As I said at the beginning, one is the simplified overhead contact system and the other is the computer-controlled interlocking system.

I will first outline the simplified overhead contact system.

The overhead contact system is the installation to supply power to electric rolling stock and is composed of supports, feeder wires, contact wires and others. Its structure is decided by taking the conditions of train operation, meteorological and various other conditions into consideration. At present, JNR is conducting research and development on many subjects including the improvement of catenary structure and parts quality with the object of preparing faster train operations, enhancing reliability and reducing construction costs. The simplified overhead contact system was studied to reduce construction costs and has recently been made practical. Its outline is as follows:

Mainly the simple catenary system is now used for conventional JNR lines as their catenary structure but udner the simplified overhead contact system, direct suspension system is used, instead. The structure of the direct suspension system is illustrated in Fig. 1. What greatly characterizes it, compared with the simple catenary system, is that it lacks the messenger wire and the hanger. This, of course, means much less construction cost but it inevitably involves more wire sag near points of support and more wire stress than in the simple catenary system. Also, the e-fect of temperature change on wiring height and wire sagging increases. These deteriorate current-collecting characteristic. To cope with this problem, it is necessary to increase the tension and reduce the effect of temperature change by using the automatic tension control system. The more the tension, the better the current collecting characteristic is. However, since the necessary residual cross-sectional area of the wire is large in proportion to tension, the life of the wire is short in proportion as its tension is large. The effect on supports must also be considered. Therefore, it is necessary to set an optimum tension in consideration of the conditions of train operation and the economy of equipment. JNR now uses tension that is 30% larger than usual. Further, the current-collecting characteristic in recently electrified JNR lines is improved by using hangers near points of support, as indicated in Fig. 2. Fig. 2 differs from Fig. 1 in that the contact wire is additionally supported inside the suspension rod. The current collecting characteristic is improved by improving the strain of the wire near the point of support by this method. I may add that it has already been ascertained both theoretically and experimentally that the current collecting characteristic can also be improved by using lighter wires and pantographs than ever.

Another characteristic of the simplified overhead contact system is the simplification of supports. This is because the weight of the catenary system as a whole is smaller, compared with the ordinary system. In the ordinary system, PC concrete poles are used as supports. As simplification of supports, there is also the method of using lightweight concrete poles but here we shall ee the outline of how to simplify the working method using H-shape steel poles.

Support poles are usually erected with their base buried in the foundation, and when putting up PC concrete poles, the fundation must be prepared with the poles already in place. H-shape steel poles are characteristic for geing able to be bolted together. Taking advantage of this cahracteristic, the work of burying the lower part of the steel poles in the foundation can be done first, and then the main part of the pole can be bolted to the pole's lower part already buried in the foundation. By using this method, it is possible to cut not only the material cost of supports but also the construction cost.

JNR has recently followed this formula in electrifying some of its lines. As a result, construction cost for overhead contact system itself has been cut by about 20%. We consider that this is an effective method to electrify lines economically in the future, taking train operation and other conditions of the lines into account.

The conditions that overhead contact system must have include superior current collecting characteristic, high reliability and maintenance capacity and low construction cost but these are affected by various factors and are mutually related in a complicated way. Particularly, the current collecting characteristic and maintenance capacity are closely related to rolling stock, too. As stated already, the current collecting characteristic is affected by the mass of the pantograph as well as by the tension and weight of the contact wire. The wear of the contact wire is also deeply concerned with the pantograph. It is desirable that the type of overhead contact system to be used should be conceived as a whole system including rolling stock. Structure, materials and construction methods must be considered comprehensively, incorporating the results of technical development into the system. Perhaps, an optimum system can be decided only when the train operating conditions, maintenance capacity and economy of each line are considred as a whole. JNR not only will study an optimum electrification system for each line in the future but is now conducting technical development aimed at more advanced electric equipment.

So much for the simplified overhead contact system. And let me now explain about the computer-controlled interlocking system.

As you know, the interlocking system is a signal control system which controls switches and signals by a station to set running route for trains and cars in safe and reliable state.

For such purposes, the system requires high reliability and fail-safe function. In the early stage of the development, the interlocking system was mechanical, and then, it became electro-mechanical.

Afterwards, a relay-interlocking system which applied signaling safety relays as logical elements was developed.

Nowadays, about 80% of all stations equipped with the interlocking system in JNR are installed with the relay interlocking system.

As an interlocking system to supersede the relay interlocking system, new systems which apply contactless elements such as magnetic amplifiers, parametrons and so on, were studied and developed about 15 years ago. But, all of them were not put into practical use due to economic and other reasons.

However, technical progress of integrated circuit, for example, micro-computer and so on, is spectacular, and the technique concerning fault-tolelance for a high reliability system continues to be developed steadily. This technical background led to the production of the system which had the cost-saving fail-safe function because of general purpose electronic parts.

Under these circumstances, JNR has been developing the computer-controlled interlocking system since 1977 and has begun designing its practical system after some trials and tests. This computer-controlled interlocking system is called the "Safety Multiprocessor system for Interlocking Equipment" or SMILE for short.

The SMILE has been developed with three targets. The 1st target is reduction of installation cost. By the application of general-purpose electronic-parts, the price of the device should be made lower.

Besides, design, production, inpection and others should be automated by the standardization of software and hardware, and therefore, the total cost would be cut down.

The 2nd target is multifunctionalization. This includes the automation of usual route setting, improvement of manipulating function, easiness of fault diagnosis, easiness of coupling with CTC system and so on.

The 3rd target is insurance of security. The new system should be much more fail-safe and reliable than the current relay interlocking system.

Moreover, by the addition of a function based on the algorithm of software to monitor the signalling devices in the field, the overall safety should be raised.

Then, I'd like to outline the fundamental design of the SMILE. The function of train traffic control is different from section to section or from station to station, although the interlocking function is invariably necessary for every station.

Thus, the multi-processor system in which a microprocessor is installed at each function-unit, has been introduced in order to cope flexibly with different functions required for different stations.

Microprocessors which can perform the functions directly associated with safety, that is, the control of switches and signals based on interlocking system and son on, should be included in the group of microprocessors constituting the SMILE. These microprocessors should have high reliability, which is the most important factor in designing of the SMILE.

Therefore, the Fail Safe Microprocessor has been newly developed. However, general-purpose microprocessors are applied for other functions. By the introduction of such multi-processor system, both fail-safe system and multi-functional ability have come to be realized efficiently. And by the application of general purpose microprocessors, the installation cost can be reduced.

As for the hardware of the SMILE, the kernel is the Fail Safe Microprocessor. Please see Fig. 3.

The configuration of the Fail Safe Microprocessor is illustrated. The fundamental structure consists of a redundant microprocessor and an error detection circuit.

The redundancy is based on a triple-Modular Redundant system. And the detection of error is done through collation of data by the Majority Voting Restorer . If a fault occurres in one module, the error is detected through ollation of data, and the output of the Majority Voting Restorer is to be corrected.

And these detection and correction are performed at each data processing between processor and memory.

Although the Majority Voting Restorer Circuit can detect and judge occurrence of a fault, disagreement is not detected in case of a fault of this Majority Voting Restorer itself.

In order to prevent such double faults, Fail-Safe Comparator is adopted. In this comparator, input data and output data of three Majority Voting Restorer are compared, and any fault occurred in a module or a Majority Voting Restorer can be detected.

This comparator is so designed that, in case of a fault of this comparator itself, the result of comparison is to become disagreement. In order to collect information from the triple modular processor and control the output, the fail-safe Output Voting Circuit is adopted. In this circuit, output is decided by majority voting through special fail-safe logical element.

When any fault is detected in a certain circuit by the Fail-Safe Comparator, logical input for the Output Voting Circuit corresponding to the faulty circuit is cut. Thus the faulty circuit is automatically cut off and the operation is switched to a dual system.

At that time, when further disagreement is detected, all of the controlled output are fixed on safe-side and the device is brought to a stop.

By the way, as I mentioned before, the SMILE is constituted by multi-processor system, which includes the Fail-Safe Microprocessor. In the case of the Multi-processor system, how to link processors comes up as a problem.

So, in the case of the SMILE, processors which functions independently are linked with one another through a system bus, and the interface has been standardized and simplified.

This arrangement is called the SMILE-bus system. Please see Fig. 4. The configuration of the practical system linked through the SMILE-bus is illustrated. The bus line is dual and processors are connected to respective buses.

Processors connected to bus are mounted on standardized sheets. The program is written into ROM beforehand, and the function required of each processor is realized only by insetion of a specific ROM.

Thus, different functions required for different stations are flexibly carried out, and the interlocking process can be modified quite easily. Diagnosis of faults in the system is performed by means of mutual diagnosis among processors.

Depending on the results of diagnosis by each processor, the diagnosis matrix is made by Fail-Safe Microprocessor, which is the most reliable in the SMILE. Thus, the diagnosis of a fault is carried out.

As for software, how to assign the functions in the system efficiently to each processor comes up as a problem.

So, the software of the SMILE is split into several functions; that is, standard function and optional function, control function and data-processing function, route-setting function and interlock-processing function, and so on.

Fundamental programs for the SMILE are interlocking, route setting, schedule planning, train traffic supervise, system monitoring, and operator console. In a specific designing of these programs, standardization and high reliability are promoted.

Especially, the software of interlocking process, which is installed in the Fail-Safe Microprocessor, is the fundamental function of the SMILE, and has some special features.

For example, programs of interlocking process are based on the algorithm of the relay interlocking system, which has successfully proved itself in the last half of the century, and peculiar interlocking conditions to each station are considred in the form of data and they are given separately from the program.

Thus the standardization of program has been promoted. The structure of data which defines the interlocking conditions of each station, is so designed that such data can represent graphically according to the track layout.

This scheme is deemed as an efficient structure of data, which can accommodate an expanded scale of interlocking with the least increase of the file capacity.

The SMILE has been developed according to the above-mentioned ideas and methods, and the first stage of the experimental system centered on the Fail-Safe Microprocessor was made by way of trial in 1979.

After one year of bench testing, the performance test of this system was begun at the ISHIUCHI Station on the Joetsu line in March 1981.

This test is being performed in a monitoring run, in which the new system is compared with the existing relay interlocking system in their functioning. This system goes on working successfully. Notably, not any danger-side output from the Fail-Safe Microprocessor has occurred at all, and the system continues to function steadily without any fault. With the good prospect of the realization of the interlocking function, the second stage of the experimental system using the SMILE-bus experimental was made by way of trial in 1983.

A synthetic confirming test of this new system was performed at the Signaling Laboratory in the Railway Technical Research Institute of JNR. In this test, it was confirmed that the system capacity was up to expectation. It was also confirmed that the automatic route setting, automatic fault detection and location, and others, were effective.

Besides, an man-machine interface for the SMILE, an operator console with Visual-Display Terminal and key-board has been newly developed. And a network to connect main body of the SMILE with local area devices such as operator console and so on, has also been developed in order to transmit data at high reliability.

Then, from the result of the tests for the experimental system in two stages, it was concluded that the SMILE was practicable enough. An the design of the practical system has been performed. The structure of the practical system is shown in Fig. 4.

In this figure, CTC interface microprocessor and TMD are optional units, while other processors or devices are standard units. And if necessary, other optional units such as Speech Recognition and Synthesis Device, Remote Monitoring

Device and so on can be connected to the SMILE.

By such configuration, the extension of the function can be performed easily. As for the fundamental functions of the SMILE, I'll outline below. The first is the interlocking function.

The SMILE performs selection of route, control of signalling devices and tracing of cars. Besides, it can block up certain tracks, prohibit the use of certain signals, observe the action of signalling devices.

The 2nd is the interface for the operator console. The SMILE indicates track layout, state of signalling devices, and others on the Visual-Display Terminal and receives such inputs as route setting, supression of automatic route setting, supression of automatic route setting, block of tracks, prohibition of the use of signals, planning and modification of train operation schedule and so on.

The 3rd is schedule planning. The SMILE memorizes basic train operation schedule, and modifies it according to the input from the operator console.

The 4th is train traffic supervision. The route is automatically set according to the train number or the request by operator.

Besides, the SMILE judges priority of route setting, and controls the train number.

The 5th is system monitoring. The SMILE memorizes the action sequence of the SMILE itself and external signalling devices, and offers the memorized information at the request of maintenance man. Besides, the SMILE has the function of fault detection and deagnosis, as I mentioned before.

The data for maintenance including the functioning state of this system and so on can be transmitted to remote places by the Remote monitoring device.

Further, the SMILE has such optional functions as direct coupling with CTC, offer of train traffic information, route setting by speech of shunting pilot, and so on.

Then, finally, I'd like to list up the effects produced by the introduction of the SMILE.

First, the installation cost can be reduced in comparison with the relay interlocking system.

2nd, the space occupied by the signal system can be reduced because of the miniturization of the device.

3rd, the working period can be shortened owing to the standardization and the automation of the design, production and inspection.

4th, the interlocking process can be modified easily, and the extension of function can be performed easily.

5th, usual manipulation by operator is needless by means of the automation of route setting.

6th, the safety of the interlocking system can be enhanced.

7th, the maintainability of the system can be raised, through the introduction of functions for diagnosis of failure in the system and for monitoring of the state of external signalling devices.

Now a practical system No. 1 is scheduled to begin operation in March next year.

JNR'S RECENT TECHNOLOGY DEVELOPMENT

- Computer Controlled Interlocking System and Simplified Overhead Contact System -

JNR is now promoting technology development in various fields for the purpose of increasing transport demand, reducing construction and operation costs, improving reliability of equipment and so on. Among many subjects of the studies, computer controlled interlocking system and simplified overhead contact system, which are closely related to railway signal engineering and electrification, are outlined below.

The simplified overhead contact system has been made practical recently in Japan. In this system, JNR has adopted direct suspension system as catenary system and H-shape steel poles as supporting structure. The cost of construction can be reduced by simplifying catenary system and improving construction method.

The computer controlled interlocking system is a new system which JNR has been developing since 1977 to supersede the current relay interlocking system. The new system is called "Safety Multiprocessor System for Interlocking Equipment", or SMILE for short. Because of the application of recent electronics technology, the SMILE is much more reliable than the relay interlocking system as a fail safe system. This system has also been developed in terms of the reduction of installing cost and the multifunctionalization.

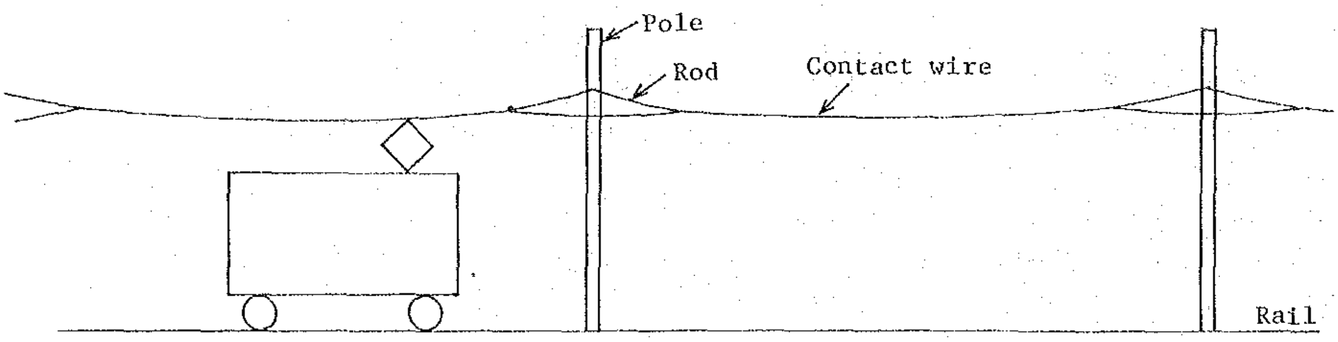

Fig. 1 Direct Suspension System

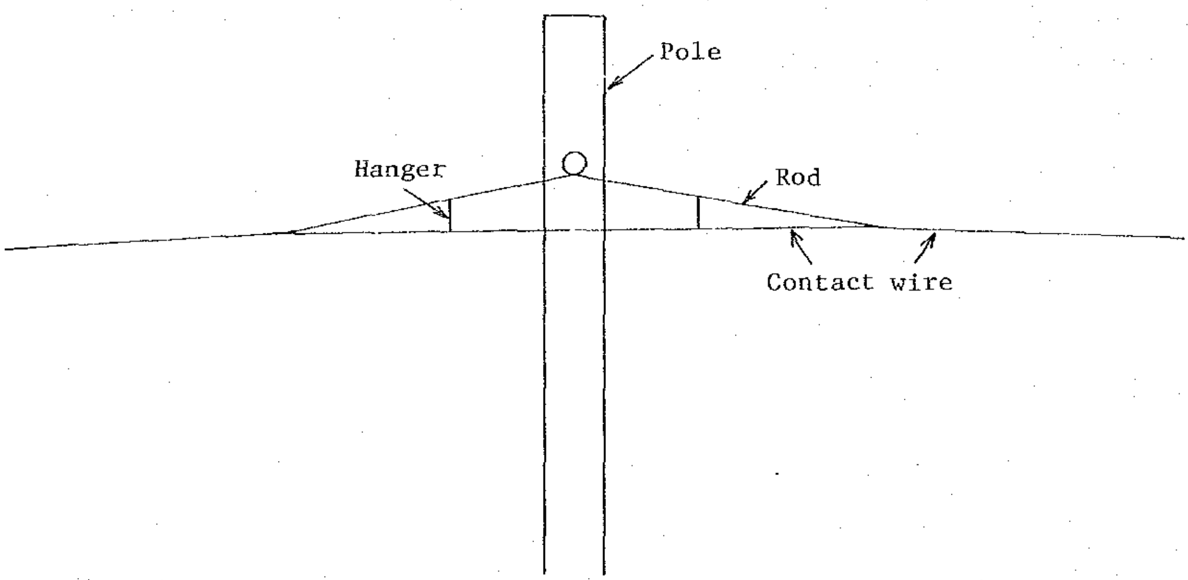

Fig. 2 Direct Suspension System (Improved)

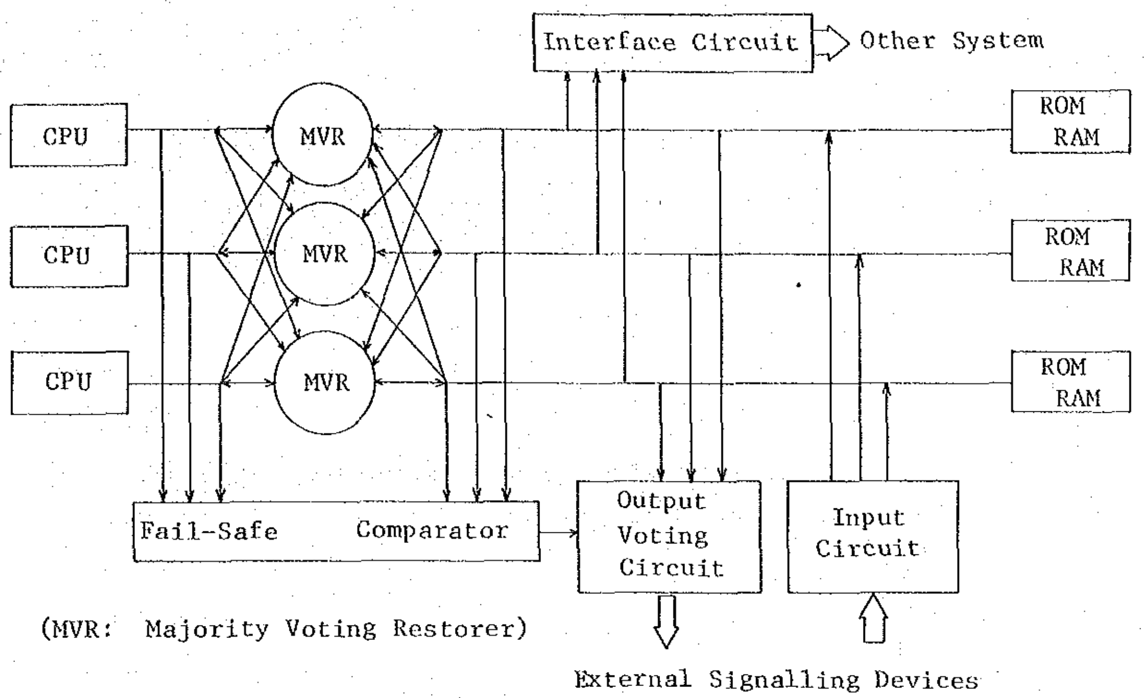

Fig. 3 Configuration of Fail-Safe Microprocessor (FSM)

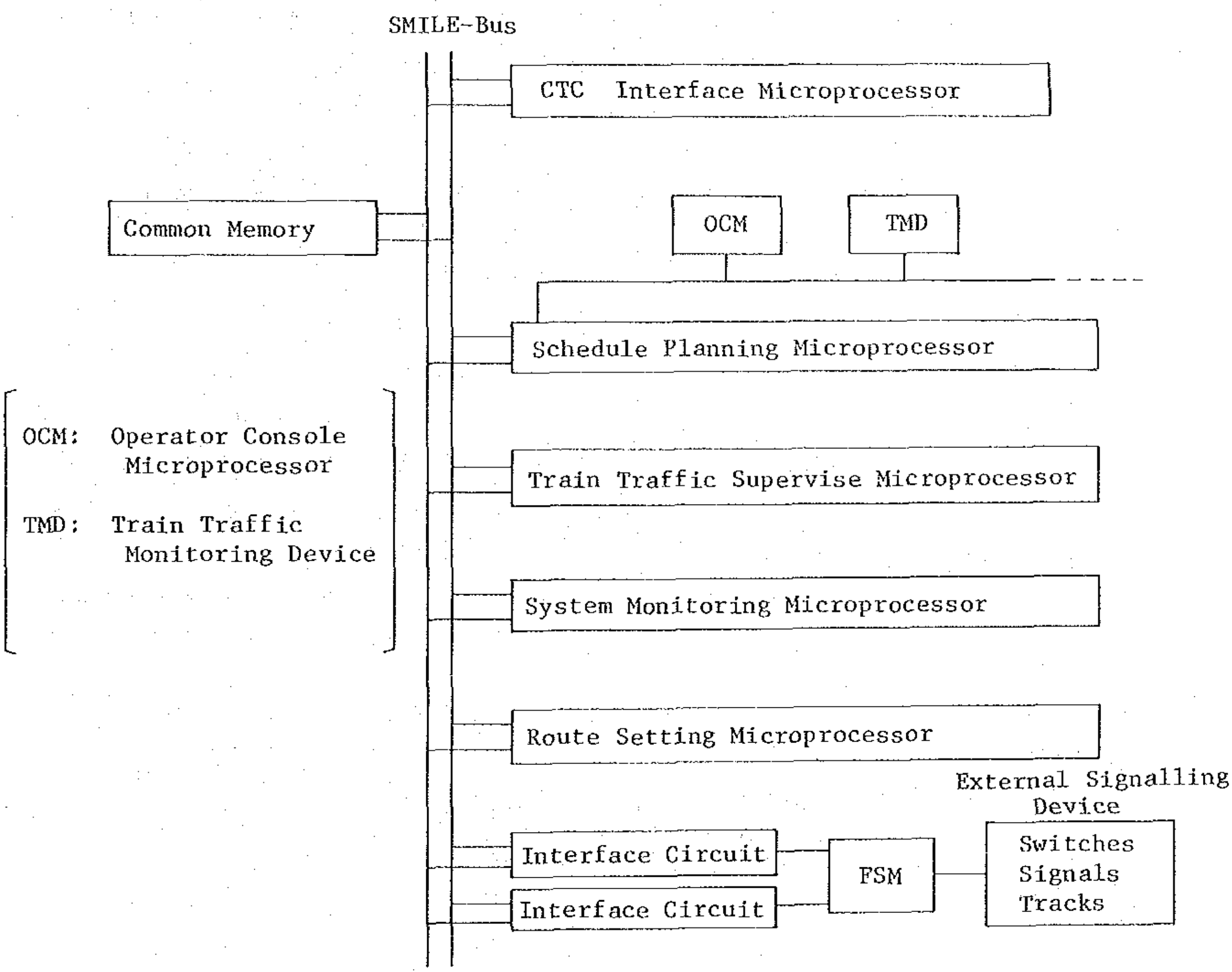

Fig. 4 Configuration of Practical System

資料 4

BRIEF REPORT OF THE TECHNICAL FOLLOW-UP TEAM FOR JICA PARTICIPANTS IN RAILWAY SIGNAL ENGINEERING AND RAILWAY ELECTRIFICATION COURSES

I. Objective

The Team primarily aims at reviewing and evaluating the fruits of the training in Japan by visiting the organizations to which the ex-participants belong, as well as through the personal interviews with the ex-participants and their superiors.

The second aim is to have a discussion meeting in order to find out their needs, effectiveness and evaluation of the said training programs, and thus to make further improvement for these training courses. Furthermore, the Team is to hold a seminar on "Present Situation of the Japanese National Railways" and "JNR's Recent Technical Development", in which the films of "Tohoku Shinkansen" and "Development of the Magnetically Levitated Transport System" are to be shown.

II. Period

From October 2 to October 5, 1984

III. Team Members

(1)	Team Leader	Mr. Yoichiro Watanabe, Director of Administration Office, National Railways Department, Secretariat to the Minister, Ministry of Transport
(2)	Technical Advisor	Mr. Masayasu Kokubo, Chief, International Cooperation Division, International Transport and Tourism Bureau, Ministry of Transport
(3)	Technical Advisor	Mr. Nobuyuki Kumagai, Assistant to the Director, International Department, Japanese National Railways
(4)	Coordinator	Mr. Tokio Asazu, Training Officer, First Training Division, Training Affairs Department, Japan International Cooperation Agency

IV. Opinions and Impressions

As a result of the discussions with the ex-participants and their superiors and the visits to the authorities concerned, the Team wishes to give the following opinions and impressions.

1. The training programs for Railway Signal Engineering and Railway Electrification Courses are found highly appreciated both by the ex-participants and their superiors

2. The Team has recognized the significance and importance of these Courses, and learned that the ex-participants have been doing their best in their respective fields, and they expect more and more strengthening and expansion of these training courses for the future.

Their requirements have been recognized as follows:

1) To implement training concerning the recent technology
2) To add optional training subjects according to the request of each participant
3) To Provide training of the particular case in electrification (form planning to construction)
4) To strengthen the field training on electrification, traffic control and procurement of rolling stocks
5) To strengthen training on the maintenance of electric facilities

The Team will report the requirements above to JICA as references for the future improvement of these training courses. Lastly the Team wishes to express sincere appreciation and gratitude to the kindness and cooperation extended by Secretaria de Comunicaciones y Transporte, Ferrocarriles Nacionales de Mexico, Instituto de Capacitacion Ferrocarrilera, Ferrocarriles Nacionales de Mexico.

Yoichiro Watanabe

Yoichiro WATANABE
Team Leader, Technical Follow-up Team for JICA ex-participants of Railway Signal Engineering and Railway Electrification Courses

cc: Embassy of Japan
JICA Mexico Office

BRIEF REPORT OF THE TECHNICAL FOLLOW-UP TEAM FOR JICA PARTICIPANTS IN RAILWAY SIGNAL ENGINEERING AND RAILWAY ELECTRIFICATION COURSES

I. Objective

The Team primarily aims at reviewing and evaluating the fruits of the training in Japan by visiting the organizations to which the ex-participants belong, as well as through the personal interviews with the ex-participants and their superiors.

The second aim is to have a discussion meeting in order to find out their needs, effectiveness and evaluation of the said training programs, and thus to make further improvement for these training courses. Furthermore, the Team is to hold a seminar on "Present Situation of the Japanese National Railways" and "JNR's Recent Technical Development", in which the films of "Tohoku Shinkansen" and "Development of the Magnetically Levitated Transport System" are to be shown.

II. Period

From October 13 to October 18, 1984

III. Team Members

(1)	Team Leader	Mr. Yoichiro Watanabe, Director of Administration Office, National Railways Department, Secretariat to the Minister, Ministry of Transport
(2)	Technical Advisor	Mr. Masayasu Kokubo, Chief, International Cooperation Division, International Transport and Tourism Bureau, Ministry of Transport
(3)	Technical Advisor	Mr. Nobuyuki Kumagai, Assistant to the Director, International Department, Japanese National Railways
(4)	Coordinator	Mr. Tokio Asazu, Training Officer, First Training Division, Training Affairs Department, Japan International Cooperation Agency

IV. Opinions and Impressions

As a result of the discussions with the ex-participants and their superiors and the visits to the authorities concerned, the Team wishes to give the following opinions and impressions.

1. The training programs for Railway Signal Engineering and Railway Electrification Courses are found highly appreciated both by the ex-participants and their superiors

2. The Team has recognized the significance and importance of these Courses, and learned that the ex-participants have been doing their best in their respective fields, and they expect more and more strengthening and expansion of these training courses for the future.

   Their requirements have been recognized as follows:

   1) Training on the maintenance of electric facilities
   2) Increase of lecture hours in makers
   3) Strengthening of the training on maintenance (e.g. Observation of maintenance depots)
   4) Strengthening of the training on telecommunication
   5) To prolong the duration of the Railway Electrification Course
   6) Sending of the up-to-date materials on signal engineering and electrification.

The Team will report the requirements above to JICA as references for the future improvement of these training courses. Lastely the Team wishes to express sincere appreciation and gratitude to the kindness and cooperation extended by Ministerio Dos Transportes, RFFSA, and CBTU.

Yoichiro Watanabe

Yoichiro WATANABE
Team Leader, Technical Follow-up
Team for JICA ex-participants of
Railway Signal Engineering and
Railway Electrification Courses

cc: Embassy of Japan
Agencia de Cooperacion
Internacional del Japón

BRIEF REPORT OF THE TECHNICAL FOLLOW-UP TEAM
FOR
JICA PARTICIPANTS IN RAILWAY SIGNAL ENGINEERING AND RAILWAY ELECTRIFICATION COURSES

I. *Objective*

The Team primarily aims at reviewing and evaluating the fruits of the training in Japan by visiting the organizations to which the ex-participants belong, as well as through the personal interviews with the ex-participants and their superiors.

The second aim is to have a discussion meeting in order to find out their needs, effectiveness and evaluation of the said training programs, and thus to make further improvement for these training courses. Furthermore, the Team is to hold a seminar on "Present Situation of the Japanese National Railways" and "JNR's Recent Technical Development", in which the films of "Tohoku Shinkansen" and "Development of the Magnetically Levitated Transport System" are to be shown.

II. Period

From October 6 to October 12, 1984

III. Team Members

(1)	Team Leader	Mr. Yoichiro Watanabe, Director of Administration Office, National Railways Department, Secretariat to the Minister, Ministry of Transport
(2)	Technical Advisor	Mr. Masayasu Kokubo, Chief, International Cooperation Division, *International Transport and Tourism Bureau*, Ministry of Transport
(3)	Technical Advisor	Mr. Nobuyuki Kumagai, Assistant to the Director, International Department, Japanese National Railways
(4)	Coordinator	Mr. Tokio Asazu, Training Officer, First Training Division, Training Affairs Department, Japan International Cooperation Agency

IV. Opinions and Impressions

As a result of the discussions with teh ex-participants and their superiors and the visits to the authorities concerned, the Team wishes to give the following opions and impressions.

1. The training programs for Railway Signal Engineering and Railway Electrification Courses are found highly appreciated both by the ex-participants and their superiors

2. The Team has recognized the significance and importance of these Courses, and learned that the ex-participants have been doing their best in their respective fields, and they expect more and more strengthening and expansion of these training courses for the future.

   Their requirements have been recognized as follows:

   1) To implement training concerning the recent technology
   2) To establish a new advanced training course for the ex-participants
   3) To stregthen the training on telecommunication
   4) Training on the improvement of railway facilities in electrification
   5) Application of electronic technology
   6) Training on the particular case in electrification from planning to the construction
   7) Field training concerning electrification, traffic control and procurement of rolling stocks
   8) Training on the maintenance of electric facilities

The Team will report the requirements above to JICA as references for the future improvement of these training courses. Lastly the Team wishes to express sincere appreciation and gratitude to the kindness and cooperation extended by FA, its staffs and ex-participants.

Yoichiro Watanabe

Yoichiro WATANABE
Team Leader, Technical Follow-up
Team for JICA ex-participants of
Railway Signal Engineering and
Railway Electrification Courses

cc: Consulate General of Japan
JICA BRASILIA OFFICE
JAMIC-Imigração e Colonização Ltda.

技術協力進める

ア国国鉄帰国研修員 巡回指導班も来ア

ア国々鉄中央研修センター設立に協力の事前調査団が来アすることを報じたが、更にア国々鉄への技術協力の一環として「国鉄帰国研修員巡回指導班」が六日来アする。

この指導班はア国から日本に研修に行つたア国々鉄関係の研修員が帰つてから、どのように日本で学んだ技術を活用しているかなどを調査、また研修員を集めてセミナーを催すなど、研修員への巡回指導を行うもの。

指導班のメンバーは次の通り。

▽渡辺要一郎（運輸省大臣官房国有鉄道部労政室長）▽小久保正保（運輸省国際観光局国際協力課協力係長）▽熊谷信行（日本国有鉄道外務部補佐）▽浅津清雄（国際協力事業団研修事業部研修第一課）

一行は十日まで滞在。八日公館、国鉄総裁等に表敬訪問、九日に帰国研修員との会合、セミナーを行い、十日、国鉄施設等の視察も行う。

なお、国鉄関係の帰国研修員は約二十人で日本では信号電化の二コースで研修した人たち。

鉄道信号及び電化コース帰国研修員巡回指導報告書　昭和六十年三月

JICA